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RESEARCH MEMORANDUM

AERODYNAMIC LOADS ON AN EXTERNAL STORE ADJACENT TO AN UNSWEPT WING AT MACH NUMBERS BETWEEN 0.75 AND 1.96

By William M. Hadaway

Langley Aeronautical Laboratory
Langley Field, Va.

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESEARCH MEMORANDUM

AERODYNAMIC LOADS ON AN EXTERNAL STORE ADJACENT TO AN UNSWEPT WING AT MACH NUMBERS BETWEEN 0.75 AND 1.96

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SUMMARY

An investigation has been conducted in the 9- by 12-inch blowdown tunnel of the Langley 19-foot pressure tunnel to determine the aerodynamic characteristics of a sting-mounted Douglas Aircraft Company (DAC) store in the presence of, but not attached to, an unswept semispan cantilevered wing of aspect ratio 4.0. The influence of the store on the aerodynamic characteristics of the wing was also obtained. The store was located at two lateral and three vertical positions (with and without pylon) beneath the wing, and tests were conducted at angles of attack from -3° to 12° and at Mach numbers between 0.75 and 1.96. Test Reynolds numbers were between 1.1×10^6 and 1.5×10^6.

The presence of the store in the vicinity of the wing generally caused small changes in the slopes of the wing normal-force and bending-moment coefficient through the Mach number range. A rearward shift in wing aerodynamic center occurred at Mach numbers between 0.75 and 1.20.

The most critical store loading condition appeared to be due to store side forces, not only because of the magnitude at high angles of attack but also because the force vector was in the direction of least structural strength of the store support. At positive angles of attack, the store side forces were increased when the store was moved to a more outboard spanwise location. The presence of a supporting pylon had very powerful effects on store side-force-coefficient values at moderate and high angles of attack throughout the Mach number range. The pylon increased values of store side-force coefficient variation with angle of attack, $C_{Y_{S_\alpha}}$, to approximately twice those for the pylon-off condition with the store axis one-store diameter below the wing.

Significant store side-force increments were indicated at supersonic Mach numbers when the store was affected by the interference field propagated from the fuselage nose.

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INTRODUCTION

Continued use of external stores on high-speed aircraft has necessitated extensive investigation of both the effects of the stores on the aircraft performance characteristics and the effects of wing and fuselage interference on external store loads. Area rule concepts have been shown to apply to the determination of the drag of aircraft-store configurations at transonic speeds and, to some extent, supersonic speeds (ref. 1). Additional information on the effects of store size, shape, and position on aircraft performance at supersonic speeds are reported in references 2 and 3. Considerable information on external store loads is available at high subsonic speeds (refs. 4 and 5, for example); however, store loads information at transonic and supersonic speeds is rather limited (refs. 6 and 7). There is considerable need for information on external store loads at transonic and supersonic speeds both from the standpoint of structural support design and as an aid to the estimation of jettisoning characteristics. In order to provide this information, the investigation conducted at supersonic speeds in the Langley 9- by 12-inch blowdown tunnel of the effects of stores on the aerodynamic characteristics of a 45° sweptback wing, an unswept wing, and a 60° delta wing (refs. 2, 8, 9, and 10) has been extended to include the measurements of both wing and store loads at transonic as well as supersonic speeds. The results of these tests for the 45° sweptback wing are presented in reference 7 and the present report presents both wing and store data for the unswept wing. Some of the store side-force data obtained in tests with the unswept wing of the present paper, the 45° wing of reference 7, and the unpublished 60° delta wing are summarized in reference 11.

The unswept wing had an aspect ratio of 4.0, a taper ratio of 0.6, and NACA 65A004 airfoil sections. The store had a Douglas Aircraft Company (DAC) shape and was sting mounted independently of the semispan wing-body combination; at no time was the store attached to or in contact with the wing. Forces (except drag) and moments on the store and on the wing-fuselage combination were measured simultaneously through a range of wing and store angle of attack of -3° to 12°. Tests were made in a transonic nozzle at Mach numbers from 0.75 to 1.20 and at Reynolds numbers between 1.2×10^{6} and 1.5×10^{6}. Tests were also made in the three supersonic nozzles at Mach numbers of 1.41, 1.62, and 1.96 and at Reynolds numbers between 1.1×10^{6} and 1.3×10^{6}.

SYMBOLS AND COEFFICIENTS

C_N normal-force coefficient, $\frac{\text{Normal force}}{qS_w}$

C_m pitching-moment coefficient, $\frac{\text{Pitching moment about } 0.25\bar{c}}{qS_w\bar{c}}$

C_B bending-moment coefficient, $\frac{\text{Bending moment}}{qS_w\frac{b}{2}}$

C_{N_s} store normal-force coefficient, $\frac{\text{Store normal force}}{qS_s}$

C_{m_s} store pitching-moment coefficient, $\frac{\text{Store pitching moment about } 0.4l}{qS_s l}$

C_{Y_s} store side-force coefficient, $\frac{\text{Store side force}}{qS_s}$

C_{n_s} store yawing-moment coefficient, $\frac{\text{Store yawing moment about } 0.4l}{qS_s l}$

q free-stream dynamic pressure

S_w semispan wing area

$\bar{c}$ wing mean aerodynamic chord, $\frac{1}{S_w}\int_0^{b/2} c^2 dy$

c local wing chord

b wing span (twice distance from root chord to wing tip)

S_s store maximum cross-sectional frontal area

l closed store length

α angle of attack of wing, deg

α_s angle of attack of store, deg

z minimum distance from wing lower surface to store longitudinal axis, positive down

d maximum store diameter

x chordwise distance from line perpendicular to $\bar{c}$ at quarter-chord station to store $0.4l$ point

y spanwise distance from wing-root chord to store longitudinal axis

$\left(\frac{z}{d}\right)_p$ denotes pylon required to reach store when store longitudinal axis is at z distance below wing

V_o free-stream velocity

R Reynolds number based on $\bar{c}$

M Mach number

F original fuselage

F* long-nose fuselage

ΔC_{N_w}, ΔC_{m_w}, ΔC_{B_w} increments in values of C_{N_w}, C_{m_w}, and C_{B_w} due to presence of store

$\Delta\left(\frac{dC_{N_w}}{d\alpha}\right)$, $\Delta\left(\frac{dC_{m_w}}{d\alpha}\right)$, $\Delta\left(\frac{dC_{B_w}}{d\alpha}\right)$ increment in $\frac{dC_{N_w}}{d\alpha}$, $\frac{dC_{m_w}}{d\alpha}$, and $\frac{dC_{B_w}}{d\alpha}$ due to presence of store

$\frac{d}{d\alpha}$ rate of change of coefficient with angle of attack

Subscripts:

w wing and fuselage

s store

[redacted]

p pylon

f fuselage

MODELS

The principal dimensions of the semispan-wing—body combinations are shown in figure 1. As mentioned previously, the unswept wing had an aspect ratio of 4.0, a taper ratio of 0.6, and NACA 65A004 airfoil sections parallel to the airstream. The wing was fabricated from heat treated steel, and the blunt, streamwise wing tip was not faired.

The external store had a DAC shape and a fineness ratio of 8.58 based on the closed length. The store was made of steel and cut off at 80 percent of its closed store length to permit entry of an internal, electrical strain-gage balance. Store ordinates and sting-mounting arrangements are given in figure 2 and a photograph of a typical test condition is shown in figure 3. The $0.4l$ position of the store coincided with the longitudinal position of the wing $0.25\bar{c}$ for all tests.

The struts, or pylons, which were unswept, were made of brass and attached by pinning and sweating to the wing lower surface but not to the external store. The struts had NACA 65A010 airfoil sections and, for each configuration, the leading edge of the strut was located at the leading edge of the wing. The configurations tested and the relative store positions are presented in figure 4.

TUNNEL

The tests were made in the 9- by 12-inch blowdown tunnel, which was supplied with compressed air at $2\frac{1}{3}$ atmospheres by the Langley 19-foot pressure tunnel. The air was passed through a drying agent of silica gel and then through finned electrical heaters in the region between the 19-foot tunnel and the blowdown-tunnel test section to insure condensation-free flow at supersonic speeds in the test region. The criteria used for the drying and heating necessary to reduce the air dewpoint below critical values are given in reference 12.

Three turbulance damping screens were installed in the settling chamber between the heaters and the test region. Four interchangeable nozzle blocks provided test-section Mach numbers of 0.75 to 1.20, 1.41, 1.62, and 1.96.

Supersonic Nozzles

Extensive calibrations of the test-section flow characteristics of the three supersonic fixed nozzles are reported in reference 13. The calibration results indicated the following test-section flow conditions:

Average Mach number	1.41	1.62	1.96
Maximum deviation in Mach number . .	±0.02	±0.01	±0.02
Maximum deviation in stream angle, deg	±0.25	±0.20	±0.20
Average Reynolds number	1.3×10^6	1.2×10^6	1.1×10^6

Transonic Nozzle

A description of the transonic nozzle, which had a 7- by 10-inch rectangular test section, together with a discussion of the flow characteristics obtained from limited calibration tests is presented in reference 14. Satisfactory flow conditions in the test section are indicated from the minimum Mach number (0.75) to $M = 1.20$. Maximum deviations from the average test-section Mach number are given in figure 5(a). Stream-angle deviation probably did not exceed $\pm 0.1^{\circ}$ at any Mach number. The average transonic Reynolds numbers of the investigation are presented in figure 5(b) as a function of Mach number.

TEST TECHNIQUE

The semispan-wing—fuselage models were cantilevered from a five-component strain-gage balance set flush with the tunnel floor. The balance and model rotated together as the angle of attack was changed. The aerodynamic forces and moments on the model were measured with respect to the balance axes. The fuselage was separated from the tunnel floor by a 0.25-inch aluminum shim in order to minimize the effects of the boundary layer on the flow over the fuselage surface. A description of the development of this shim is given in references 15 and 16. A clearance gap of about 0.010 inch was maintained between the fuselage shim and the tunnel floor with no wind load.

The external store was attached to the forward end of an internal four-component strain-gage balance. The downstream end of the balance sting was supported by a strut from the tunnel floor, and the store and sting pivoted about a point 12.25 inches ($5.79\bar{c}$) downstream of the wing $\bar{c}/4$. The store angle of attack and position in a direction normal to its own axis were controllable within limits during tests and permitted an angle-of-attack range of about 6° per test run. The sting support was repositioned between test runs and three runs were required to obtain data throughout the angle-of-attack range from -3° to 12°.

Two small electrical contacts on the side of the store nearest the wing permitted alinement of the store with the pylon and also gave an indication of fouling between the two. A minimum gap of about 0.02 inch was maintained at all times unless otherwise stated.

Jet-boundary interference and reflection-plane effects at high subsonic speeds cannot be theoretically evaluated at present for the transonic nozzle. The experimental evidence available (refs. 7 and 14), however, indicates that the wing plus interference (wing-fuselage minus fuselage) characteristics are reasonably reliable except in the Mach number range between 0.94 and 1.04. In this range, significant quantitative differences are found between pitching moments for a sweptback wing measured in the transonic nozzle and those measured in other facilities where the ratio of tunnel cross-sectional area to model wing area was considerably larger. The store forces and moments in this speed range are believed to be relatively free from interference effects and the incremental wing forces and moments due to the presence of the store are considered reliable. (See ref. 7.) Reflection of shock or expansion waves emanating from the model back onto the wing fuselage or store by the tunnel walls is known to occur at supersonic Mach numbers less than 1.2, although at Mach numbers of 1.05 or less the effects of reflected disturbances are believed to be small. Data are not presented for the Mach number range between 1.05 and 1.2. At $M = 1.2$, the reflected fuselage bow wave is believed to pass downstream of the wing and store when the original fuselage was employed. When the extended nose fuselage was used, however, the reflected bow wave appreciably affected the store side-force and yawing-moment coefficients.

Chord forces on the semispan-wing—fuselage combination in the presence of the external store were measured but not presented because they were in error by an unknown amount due to interference of the store balance supporting strut on fuselage base pressures. (See ref. 7.) For this reason, measured normal forces for this condition could not be rotated to the wind axis and presented as lift.

ACCURACY OF MEASUREMENTS

An estimate of the probable errors introduced in the present data by instrument reading errors and measuring equipment errors are presented in the following table:

C_{N_W}	± 0.01
C_{m_W}	± 0.002
C_{B_W}	± 0.002
α, deg	± 0.05
C_{N_S}, C_{Y_S}	± 0.01
C_{m_S}, C_{n_S}	± 0.001
α_s, deg	± 0.20
x	$\pm 0.015\bar{c}$
y	$\pm 0.01b/2$
z	$\pm 0.03d_s$

The measurement accuracy given above for the store angle of attack refers to the angle betweeen the store and the wing and does not include inaccuracies in measurement of the wing-fuselage angle of attack. The minimum gap and the alinement between store and wing in the pitch plane was fixed by setting the heights of the electrical contacts on the store with wind off. Alinement during tests was determined by simultaneously making or breaking of the two electrical contacts on the store. The vertical position was then determined by means of a calibrated lead screw which moved the store normal to its longitudinal axis. Therefore, the store angle of attack and vertical position relative to the wing were essentially independent of deflection of the store supporting system or of the wing due to air loads. In the lateral plane, the store-position measurement accuracy was determined principally by the deflection of the balance sting due to air loads on the store and sting. These deflections were determined from static load calibrations. The longitudinal location of the store was fixed before each run. The accuracy given above was essentially the variation in x relative to the wing during each run due to different points of rotation of the wing and the store.

Tests of the store alone were made both with electrical contacts raised and with the contacts faired smooth with the store surface. Differences in the measured loads were well within the stated experimental accuracies.

RESULTS AND DISCUSSION

It shold be noted that for all store positions tested, a pylon was attached to the wing. In the case of the store located one-half store diameter (plus a very small gap) below the wing lower surface, the pylon was little more than a fairing between wing and store. Therefore, when the store was moved away from the wing, without changing the pylon, a condition existed that will be referred to as the "pylon off" condition.

An index of the figures presenting the results is as follows:

Wing Loads

The absolute values of the wing-fuselage force and moment coefficients have little if any application to conventional wing-fuselage configurations because of the arbitrary shape of the test body which includes the boundary-layer shim. The changes in wing-fuselage characteristics due to the presence of the store are believed to be reliable and are of primary interest.

In general, the presence of the store caused small changes in the slope at $\alpha = 0^{\circ}$ of the wing normal-force and bending-moment coefficients against angle of attack $\left(\frac{dC_{N_w}}{d\alpha}\right)$ and $\left(\frac{dC_{B_w}}{d\alpha}\right)$. A rearward shift in wing aerodynamic center occurred at Mach numbers from 0.75 to 1.20 (fig. 12).

Store Loads

For the store in the presence of the wing, slope values of the store normal-force coefficient against angle of attack $\left(\frac{dC_{N_s}}{d\alpha}\right)$ were, in general, negative or near zero at low positive angles of attack throughout the Mach number range tested (figs. 10 and 11). As a consequence, the store normal-force coefficients at the higher angles of attack were considerably smaller than the store alone values.

Probably the most significant results of the investigation are indicated by the store side-force characteristics with the store in the presence of the wing.

Effect of store spanwise location.- The effect of shifting store spanwise location is shown by data obtained at store positions adjacent to the wing ($z/d_s = 0.5$). Figure 11 indicates that at station $2y/b = 0.80$, large negative (outwardly directed) store side-force coefficients were encountered generally at positive angles of attack throughout the range of Mach numbers. These coefficients indicate large side forces at supersonic speeds and present serious problems since the force is in the direction of the least structural strength of the pylon. The store side force was not as pronounced at $2y/b = 0.47$ even at angle of attack, and the values of $C_{Y_{s_\alpha}}$ (measured at $\alpha = 6^{\circ}$) for the store adjacent to the wing (fig. 14(a)), ($z/d_s = 0.5$) were approximately one-half of those for the store adjacent to the wing at $2y/b = 0.80$ throughout the Mach number range tested (figs. 14(a) and 14(b)). Reference 5 indicates that still larger side-force coefficient and $C_{Y_{s_\alpha}}$ values than those obtained at $2y/b = 0.80$ would be expected as the store is moved further outboard toward the wing tip at subsonic speeds. For the two spanwise store positions tested, these data indicate that, from the store-pylon-loads viewpoint, the most favorable spanwise locations are inboard. However, the best spanwise locations of the store from consideration of wing-fuselage-store minimum drag at supersonic speeds (ref. 9) is near the wing tip.

Effect of store vertical location and support pylon.- At all Mach numbers, moving the store vertically from $z/d_s = 0.5$ to $z/d_s = 1.0$ (pylon off) decreased both the $C_{Y_{s_\alpha}}$ values and the side-force coefficients at moderate and high angles of attack by about one-half at both spanwise stations $2y/b = 0.47$ (figs 10 and 14(a)) and $2y/b = 0.80$ (figs 11 and 14(b)). The data at supersonic speeds indicate that further displacement of the store from the wing at $2y/b = 0.47$ (pylon off) reduced the values of $C_{Y_{s_\alpha}}$ only slightly more, but at transonic speeds the data are limited to $\alpha = 3^\circ$ and are inconclusive. Movement of the store from $z/d_s = 0.5$ to $z/d_s = 1.0$ (with connecting pylon) at station $2y/b = 0.80$ (the only station at which this was done) resulted in very little change in values of $C_{Y_{s_\alpha}}$ (figs. 11 and 14(b)). These effects are shown more clearly in figure 15 where side-force coefficients are plotted against vertical position with and without a pylon at $M = 1.62$. Included in the figure are data taken from reference 7 for the store in the presence of a 45° sweptback wing. These data demonstrate the powerful effects that the pylon can exert on the store side-force loads at moderate to large angles of attack. It appears that these very large effects on store side force result from restriction of the lateral flow between the store and the wing. These results are typical of those obtained at subsonic as well as supersonic Mach numbers. Furthermore, it is probable that very large side-force loads are carried on the pylon itself. The data indicate that very small gaps between the store and the wing (or pylon) can introduce substantial changes in measurements of side-force loads when wing and store are mounted independently, as in a wind tunnel.

In the presence of the 45° sweptback wing of reference 7, the store was skewed 5° inboard and the side-force curves were shifted, thereby relieving the side loads at high angles of attack although the large negative slopes were not changed. The store was not skewed in this investigation; however, it would appear that similar results would be realized.

Effect of relative fuselage nose-store nose position.- In an effort to determine the effect of the fuselage nose position relative to the store location, the fuselage forebody was extended forward 1/2 store length and limited data were obtained for the store position $2y/b = 0.80$

and $z/d_s = 0.5$ both in the presence of the wing-fuselage combination and in the presence of the fuselage alone. For the store in the presence of fuselage alone, the effects of fuselage nose position on store side-force and yawing-moment coefficients were negligible below $M = 1.0$ (not shown) but were sizable above $M = 1.0$ (fig. 16(c)). The side-force-coefficient values indicated for the store alone are due to model misalinement; however, the incremental store side-force values due to the presence of either fuselage are considered reliable. The effect upon C_{Y_S} was exaggerated by the presence of the wing at supersonic Mach numbers and extending the fuselage nose position resulted in a large reduction in store side-force change with Mach number above $M = 1.2$. At $M = 1.2$, the side-force coefficients were probably affected by reflection off the tunnel walls of the bow wave from the extended nose fuselage since the reflected shock passes behind the store only in the case of the original fuselage. At higher Mach numbers, disturbances from the fuselage fore body affect the store side forces directly. At Mach numbers greater than 1.4, the large negative side-force coefficients appear to result from the influence of the positive-pressure interference field propagated from the fuselage nose. The magnitude of the coefficients was reduced by more than 50 percent at $\alpha = 0^{\circ}$ when the fuselage forebody was extended so that the bow wave passed well ahead of the store nose (note relative position of Mach lines in fig. 16(c)). The effect of fuselage nose position on store normal forces and pitching moments was small and unimportant and these data are not presented.

CONCLUSIONS

An investigation of the aerodynamic forces (except drag) and moments on both an unswept wing-fuselage combination and an external DAC store in the presence of each other at Mach numbers between 0.75 and 1.96 indicates the following:

1. The presence of the store in the vicinity of the wing generally caused small changes in wing normal-force- and bending-moment-coefficient slopes. A rearward shift in wing aerodynamic center occurred at Mach numbers from 0.75 to 1.20.

2. The most critical store loading condition appeared to be due to store side forces, both because of its magnitude at high angles of attack and because its direction was in that of the least structural strength of the pylon.

3. At positive angles of attack, the store side forces were increased when the store was moved to a more outboard spanwise location.

4. The presence of a supporting pylon had very powerful effects on store side-force-coefficient values at moderate and high angles of attack throughout the Mach number range. The pylon increased values of store side-force variation with angle of attack to approximately twice those for the pylon-off condition with the store axis one store diameter below the wing.

5. Significant store side-force increments were indicated at supersonic Mach numbers when the store was affected by the interference field propagated from the fuselage nose.

Langley Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., Nov. 16, 1955.

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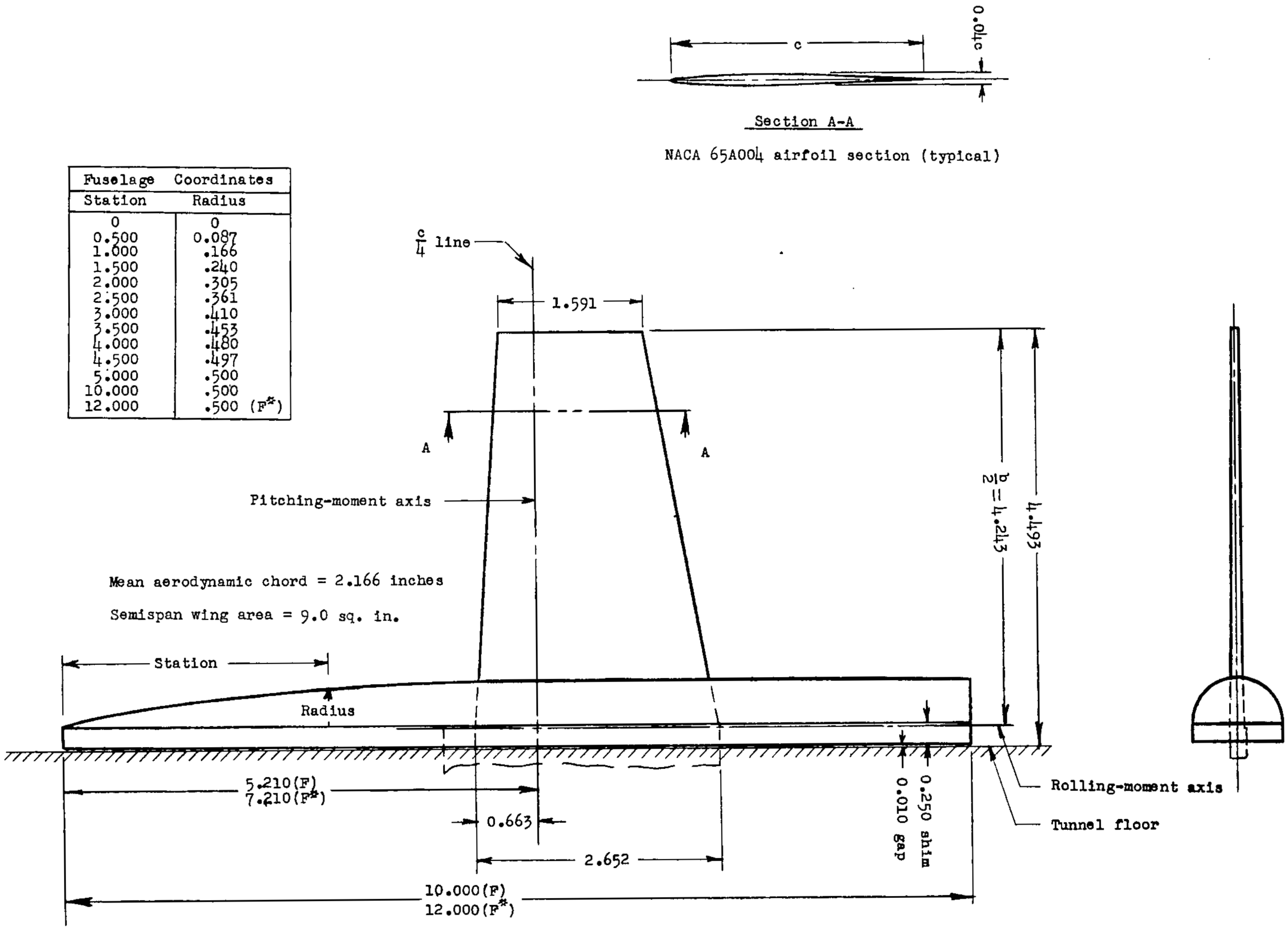

Fuselage Coordinates	
Station	Radius
0	0
0.500	0.087
1.000	.166
1.500	.240
2.000	.305
2.500	.361
3.000	.410
3.500	.453
4.000	.480
4.500	.497
5.000	.500
10.000	.500
12.000	.500 (F*)

Figure 1.- Details of unswept semispan wing of aspect ratio 4. All dimensions are in inches.

Douglas Store Ordinates	
Station	Radius
0	0
0.076	0.036
.188	.080
.299	.116
.411	.140
.519	.160
.630	.176
.742	.188
.966	.211
1.185	.227
1.408	.233
1.983	.233
2.206	.229
2.426	.219
2.645	.203
2.873	.184
3.200	.148
3.990	0

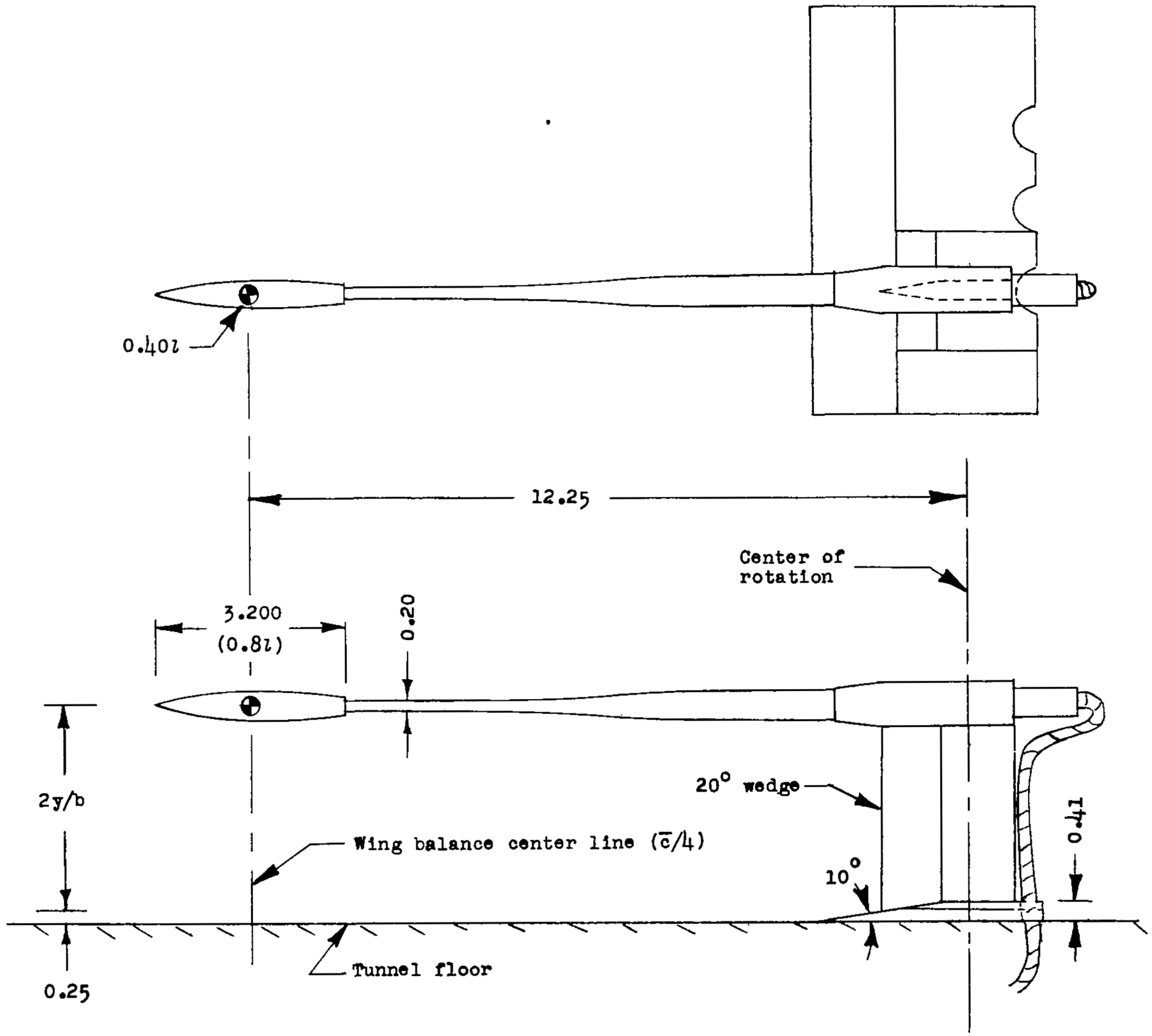

Figure 2.- Details of the sting-mounted DAC store. All dimensions are in inches.

[redacted]

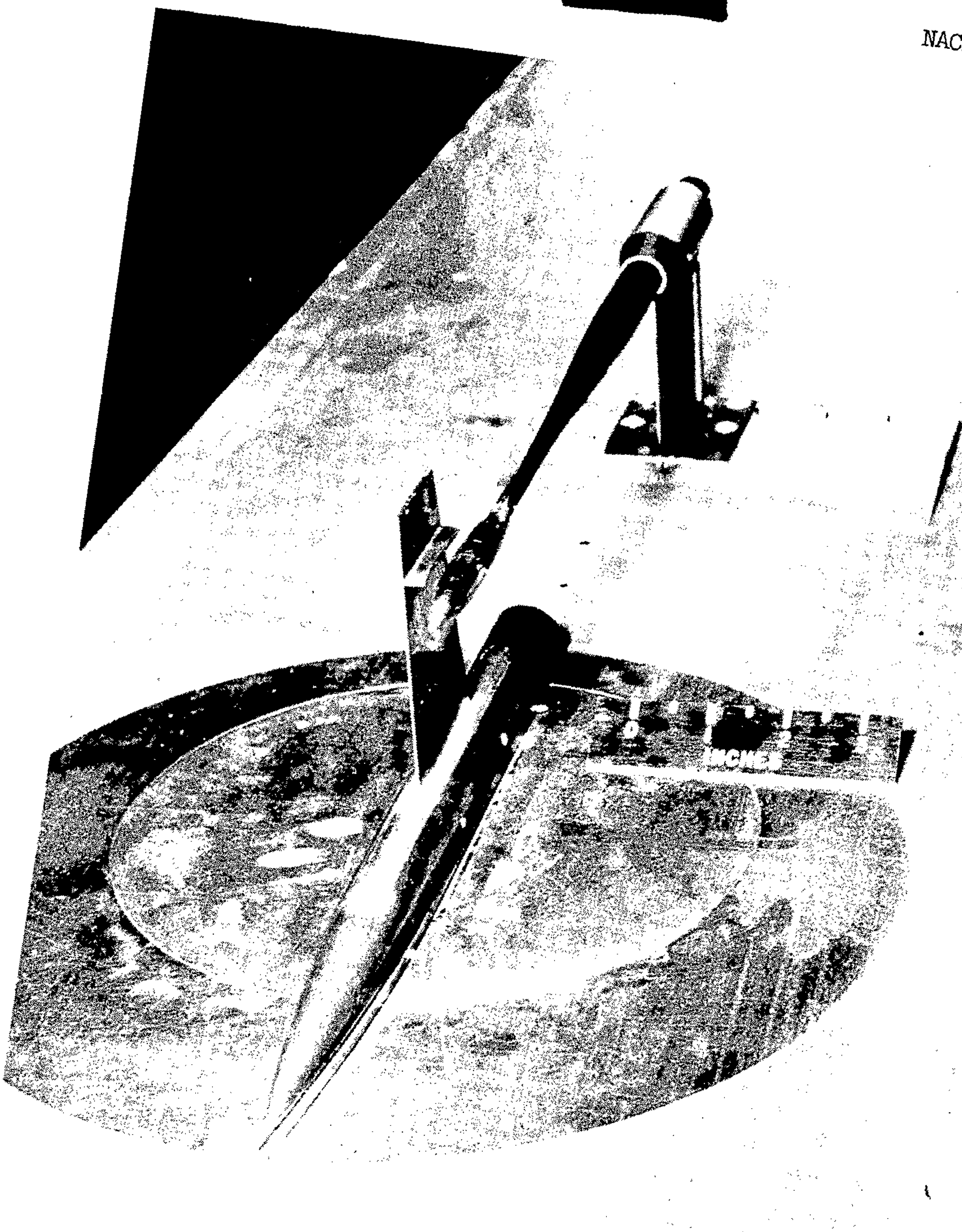

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Figure 3.- Photograph of a typical test setup (store position = $2y/b = 0.80$; $z/d_p = 1.0$; $z/d_s \approx 1.5$; $x/\bar{c} = 0$).

[redacted]

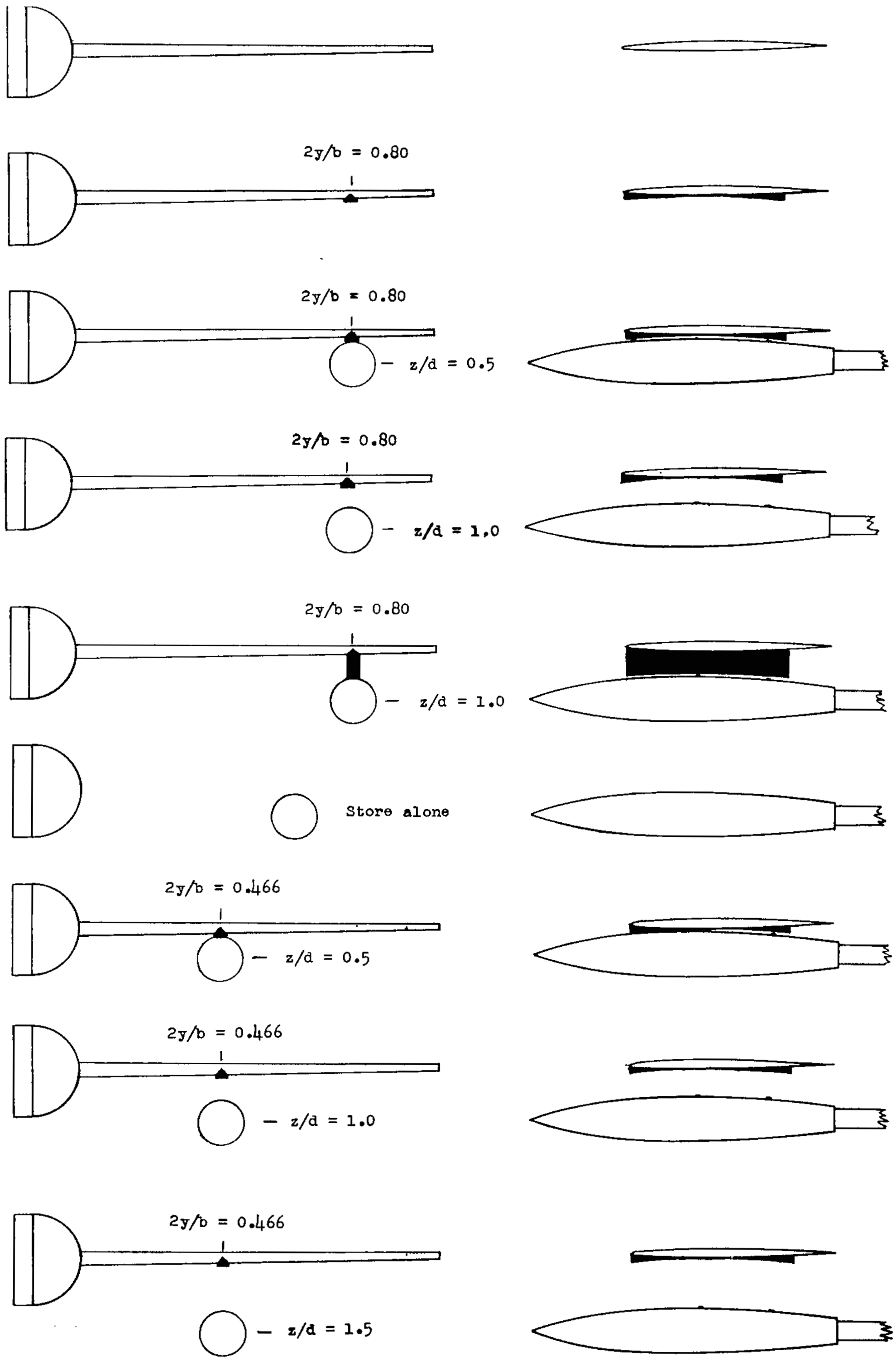
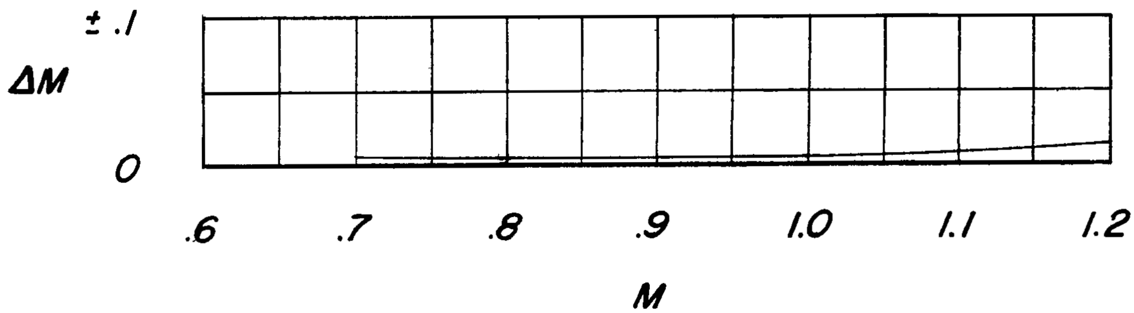
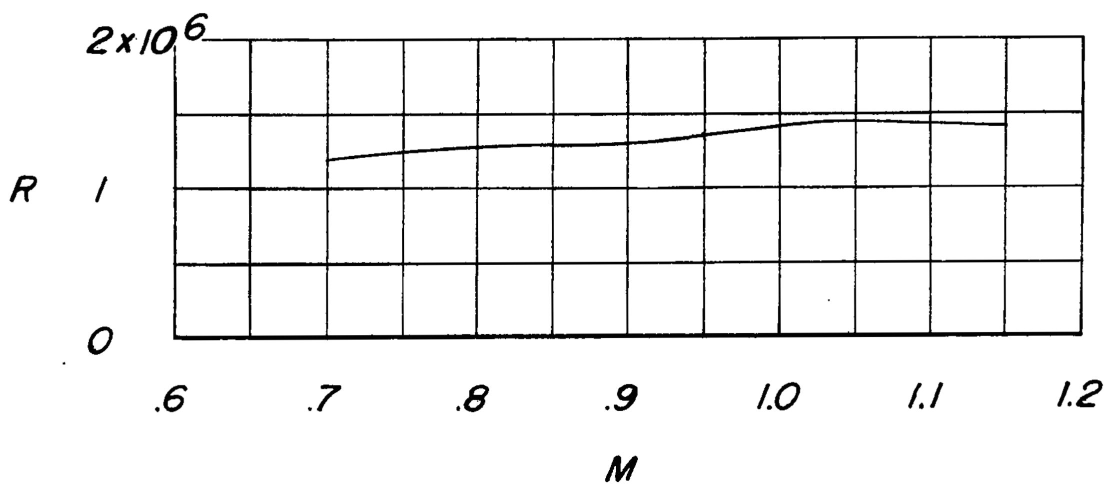


Figure 4.- Configurations tested for Mach numbers between 0.75 and 1.96. $\frac{x}{\bar{c}} = 0$.



(a) Maximum deviation from average test-section Mach number (tunnel clear).



(b) Variation of test Reynolds number, based on $\bar{c}$, with Mach number.

Figure 5.- Variation of Reynolds number and deviation of test region Mach number with Mach number.

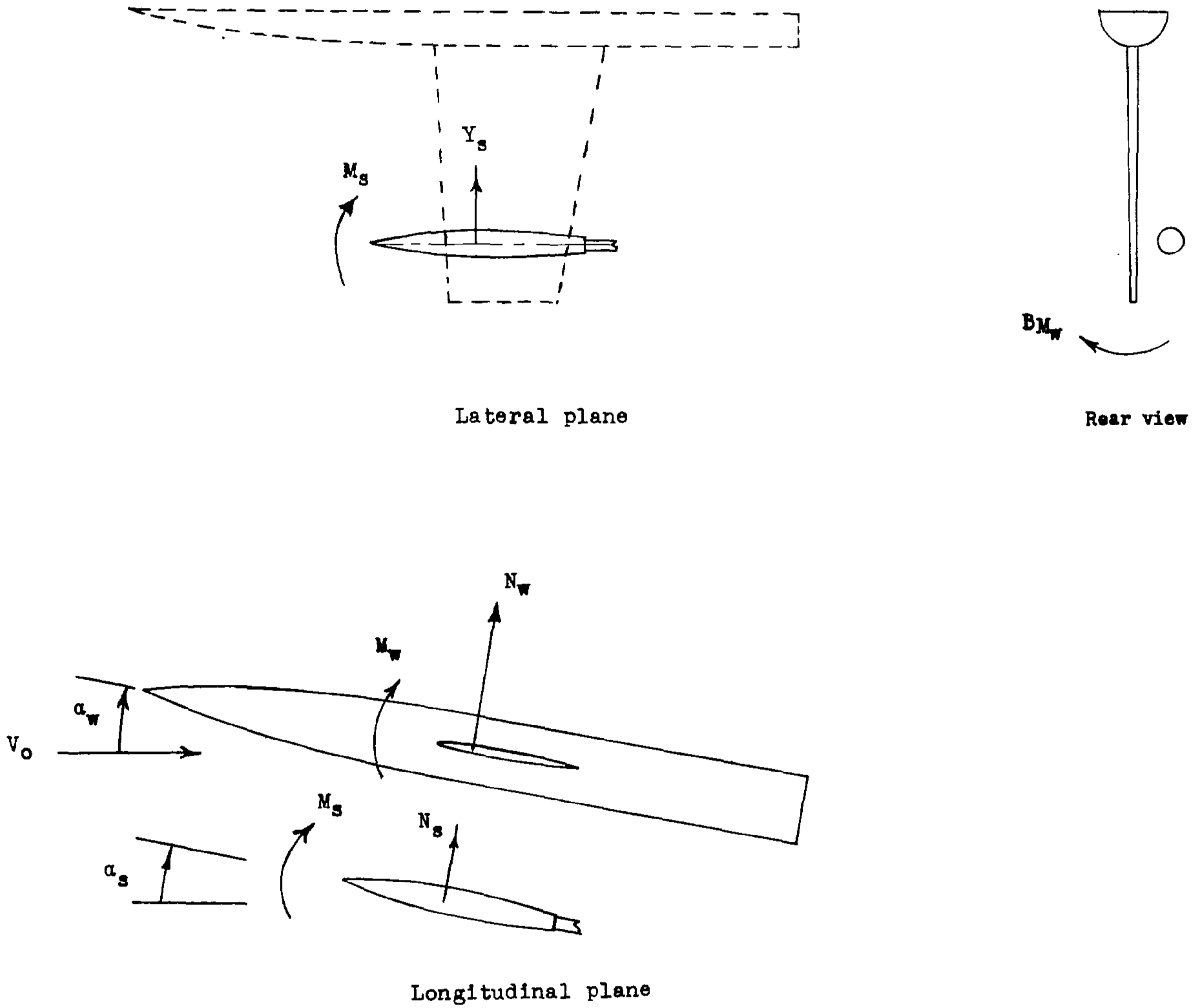


Figure 6.- Positive direction of forces and moments measured on cantilevered wing-fuselage model and on sting-mounted store model.

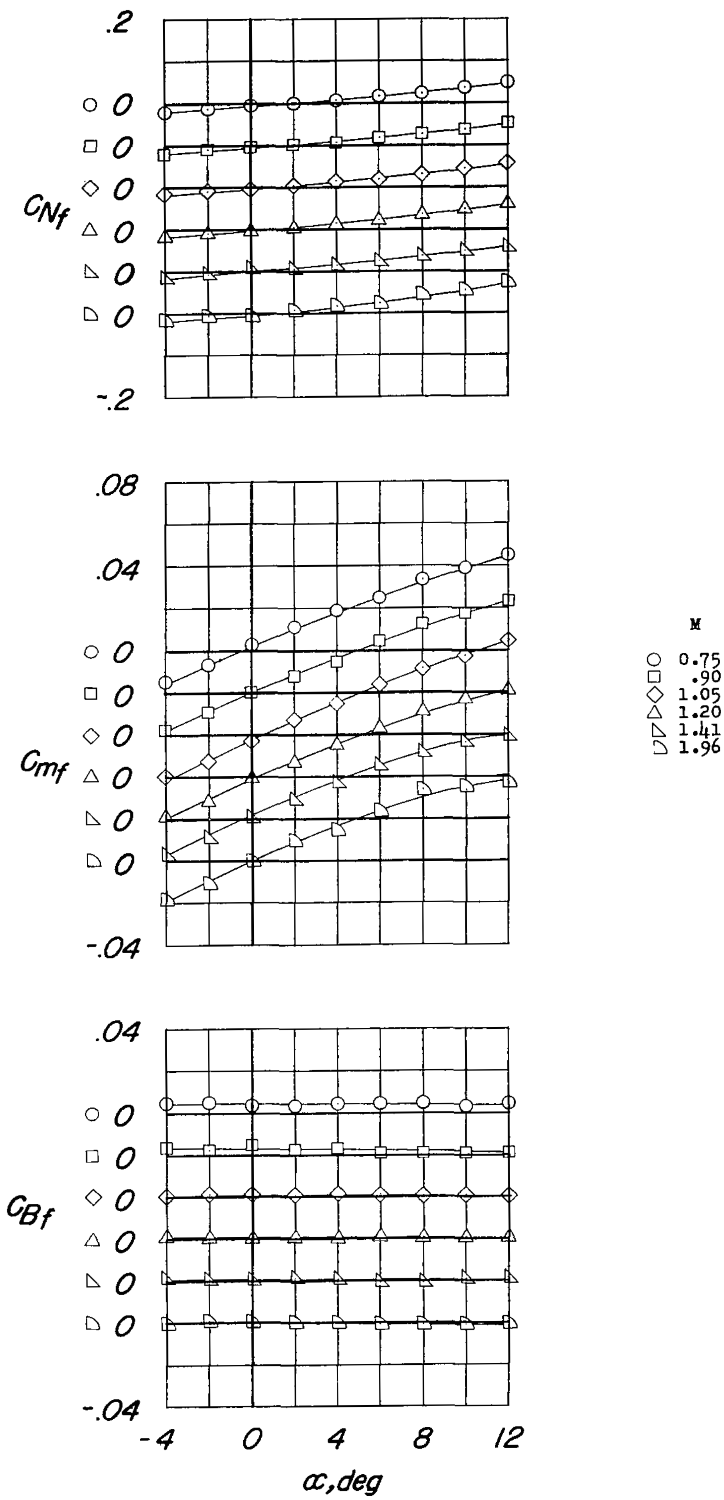
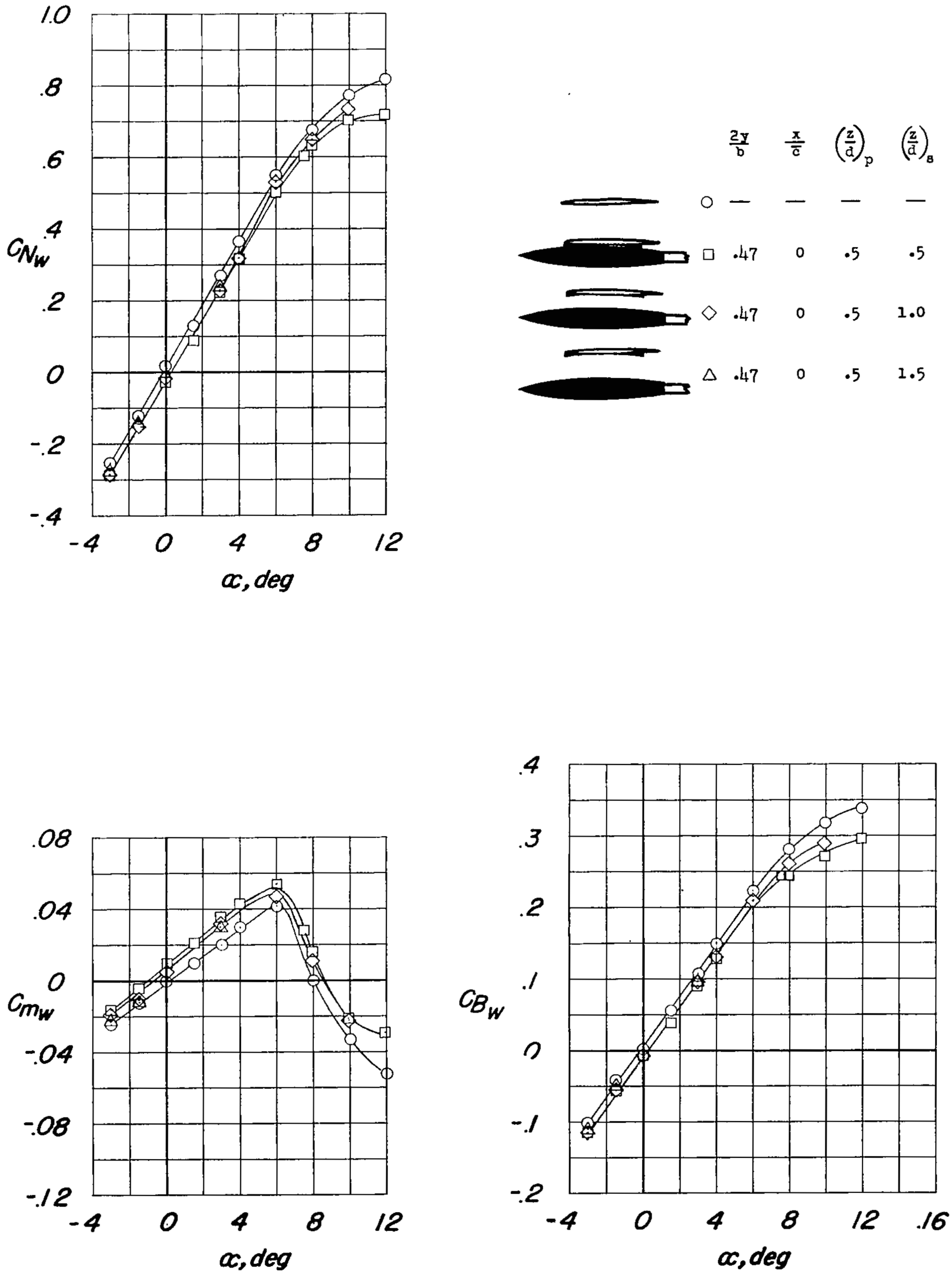
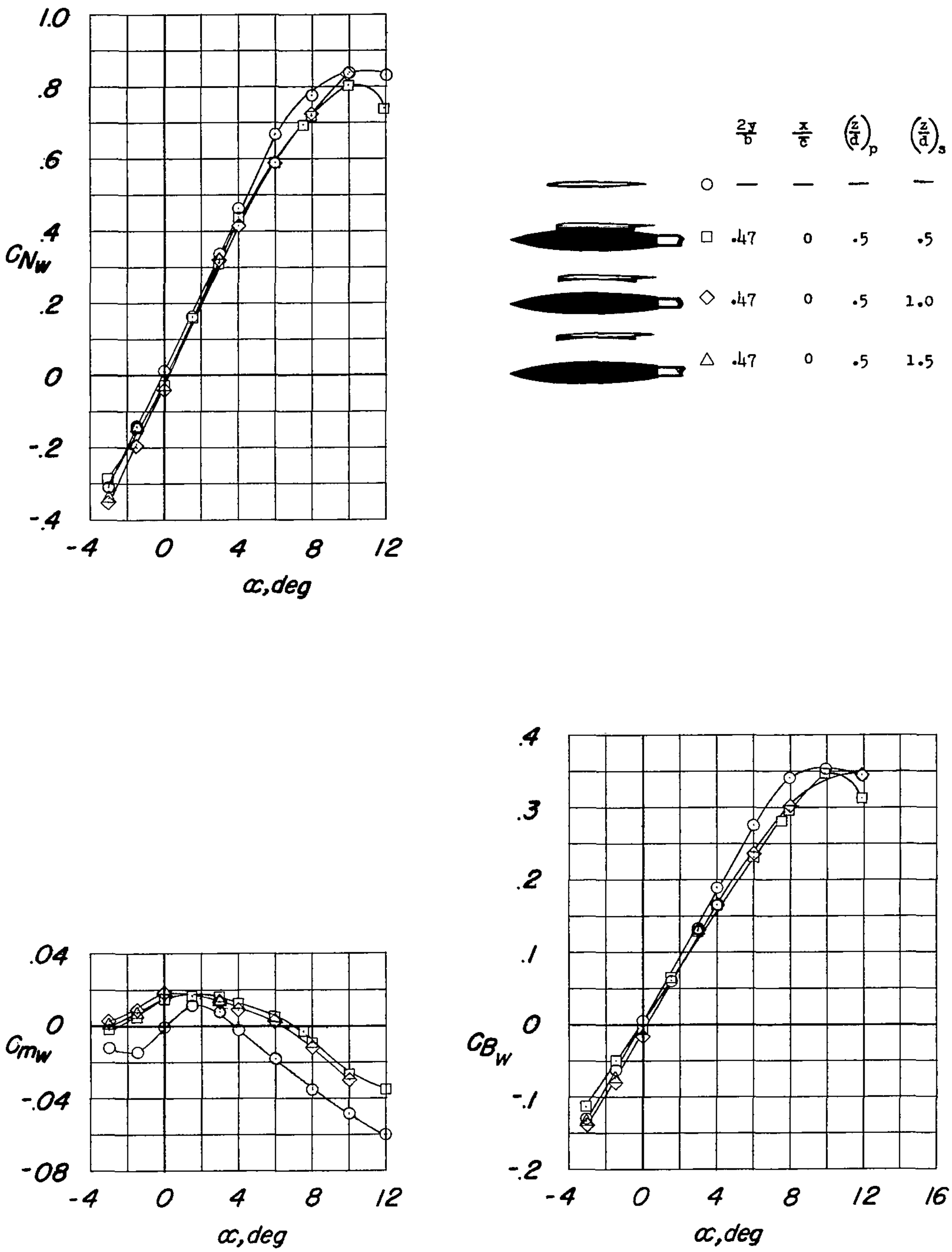


Figure 7.- Aerodynamic characteristics of original fuselage alone.



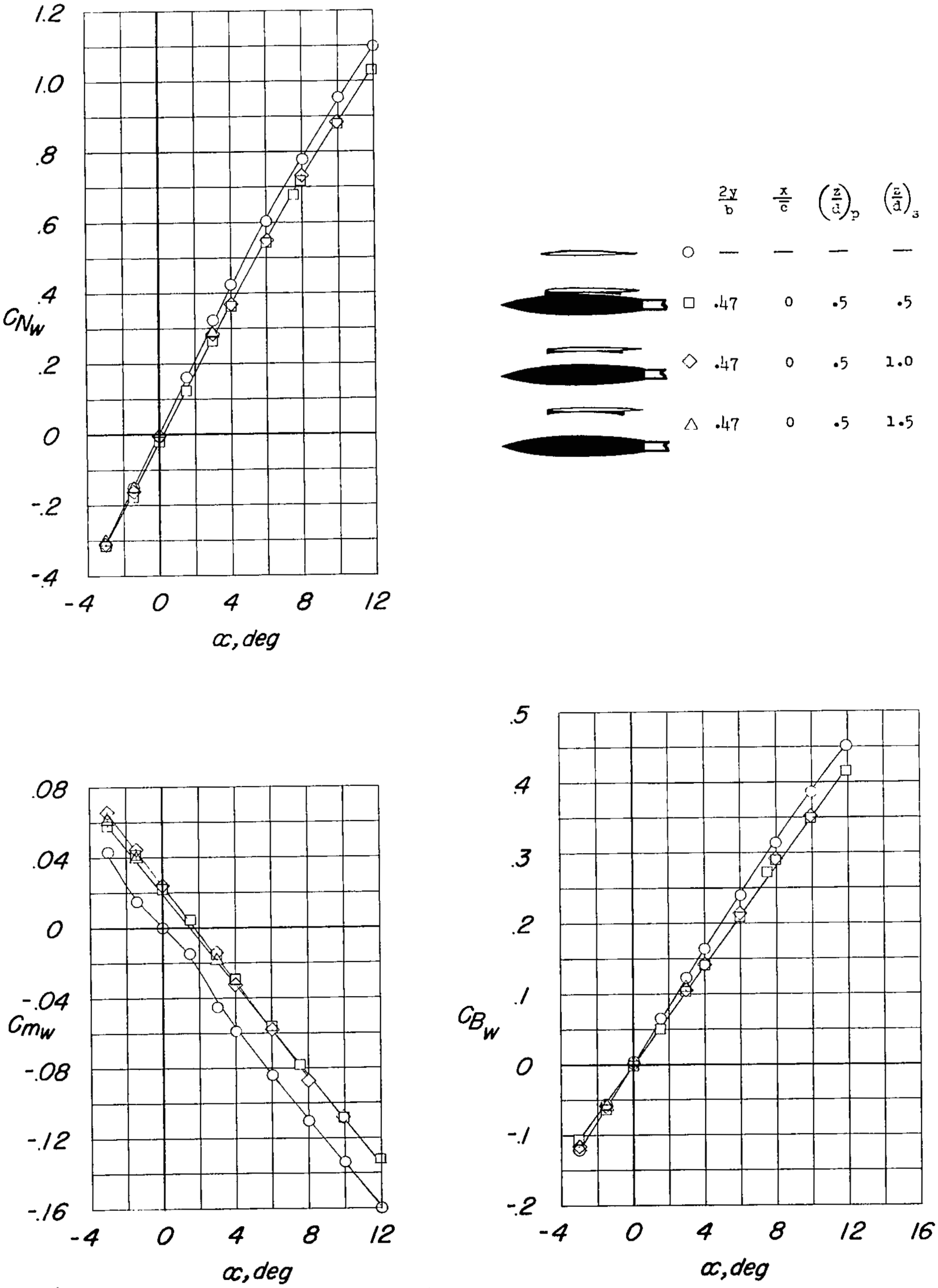
(a) M = 0.75.

Figure 8.- Influence of DAC store at various vertical positions on aerodynamic characteristics of wing-fuselage. 2y/b = 0.47; original fuselage.



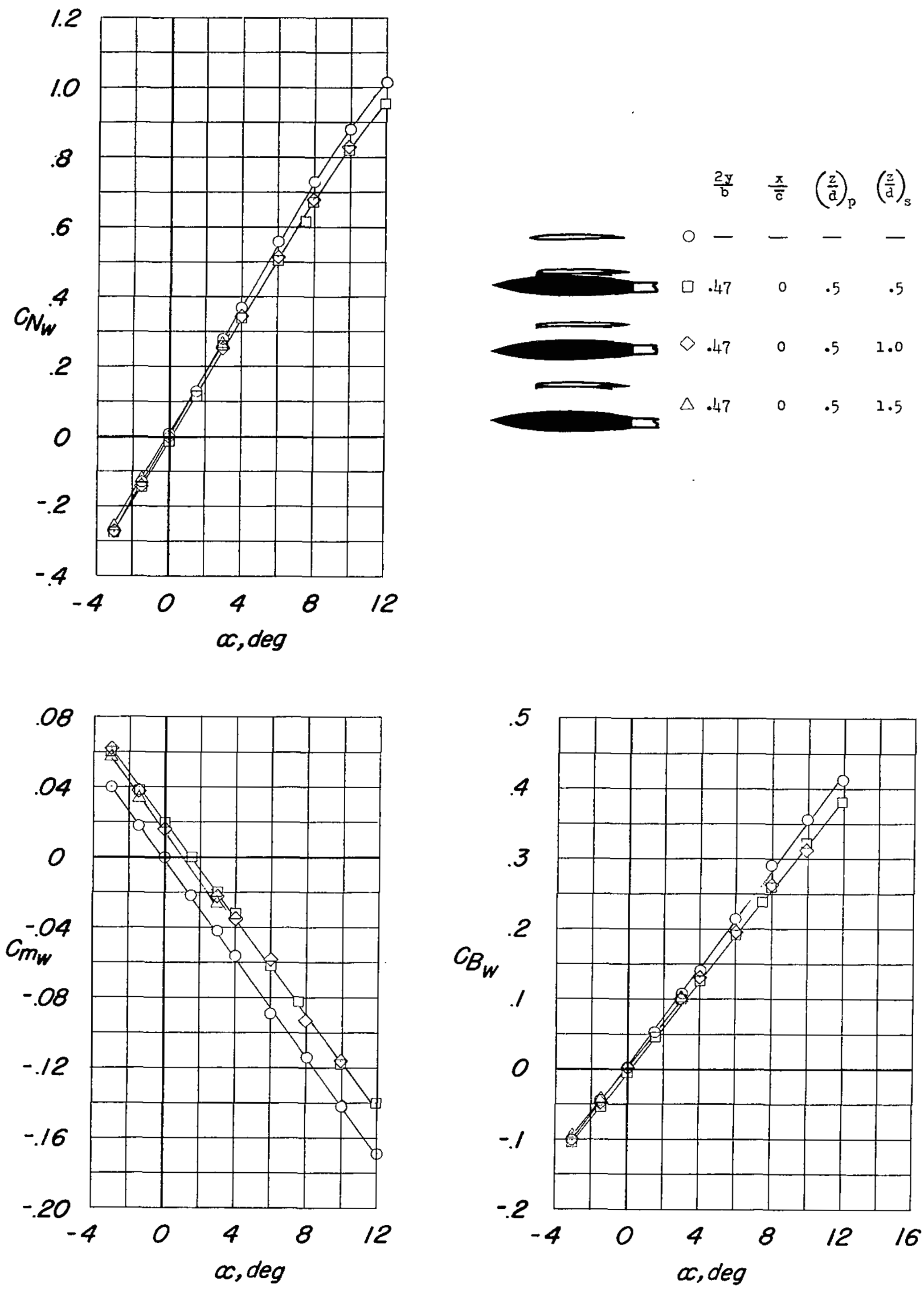
(b) M = 0.90.

Figure 8.- Continued.



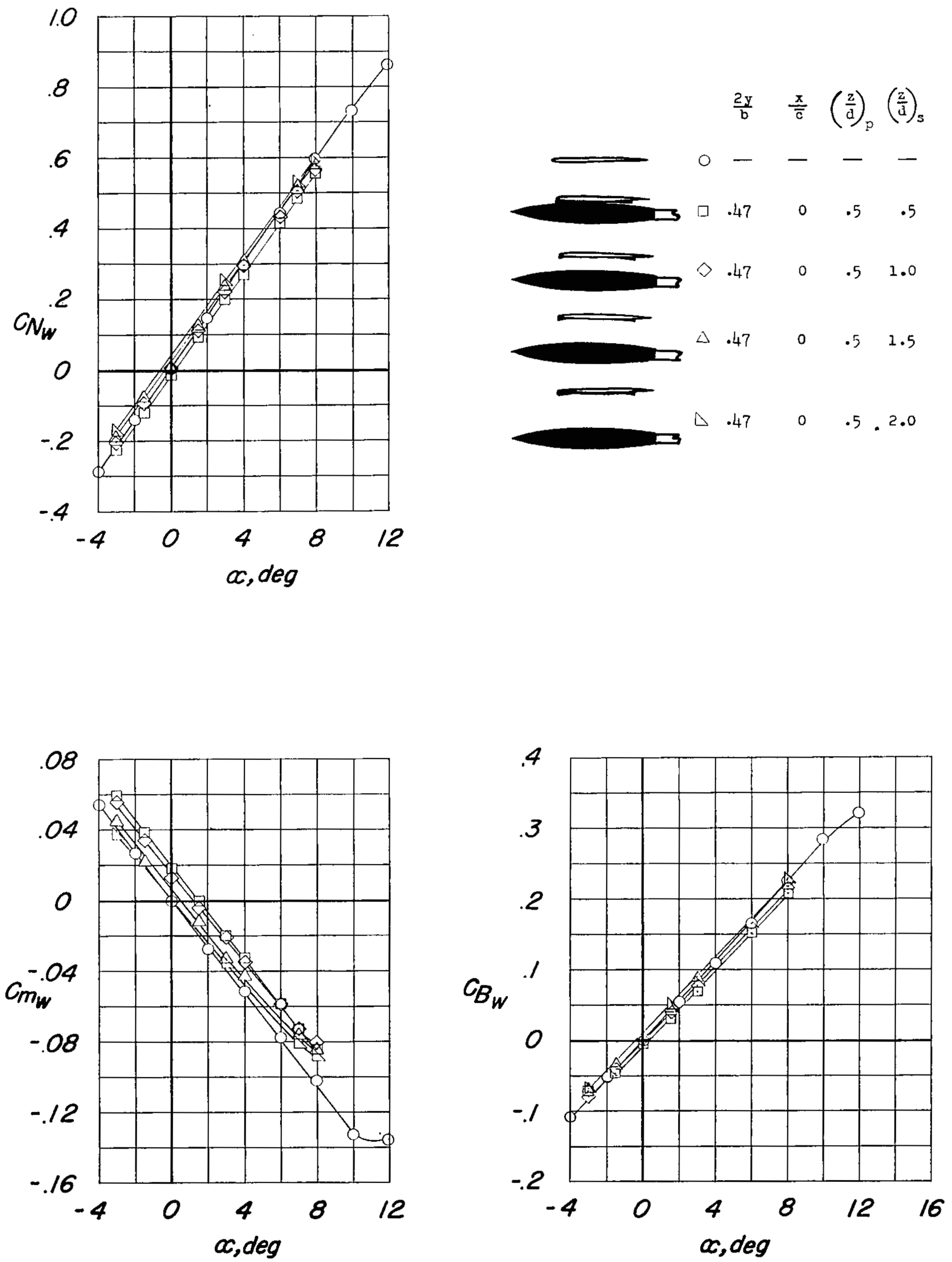
(c) M = 1.05.

Figure 8.- Continued.



(d) M = 1.20.

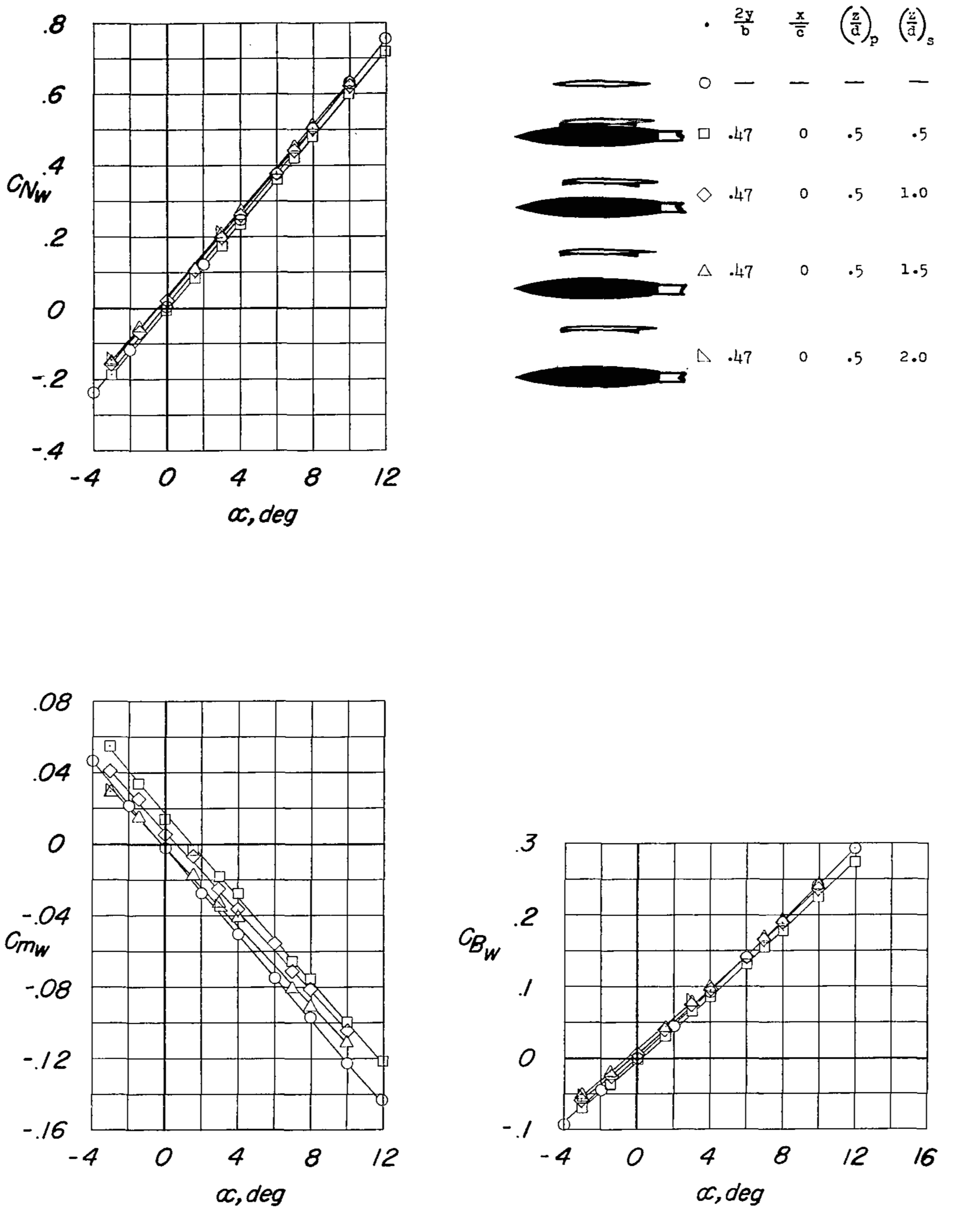
Figure 8.- Continued.



(e) M = 1.41.

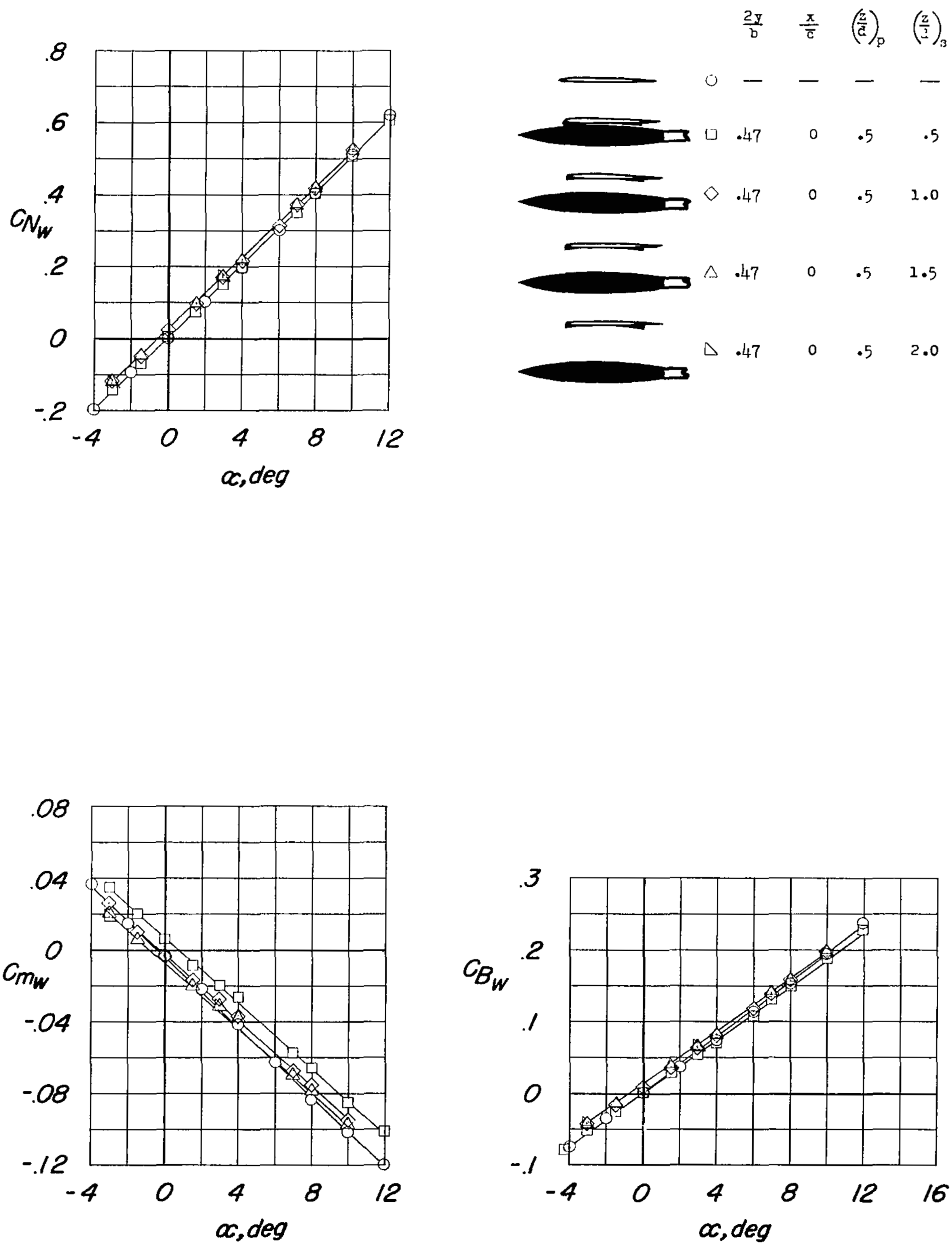
Figure 8.- Continued.

[redacted]



(f) M = 1.62.

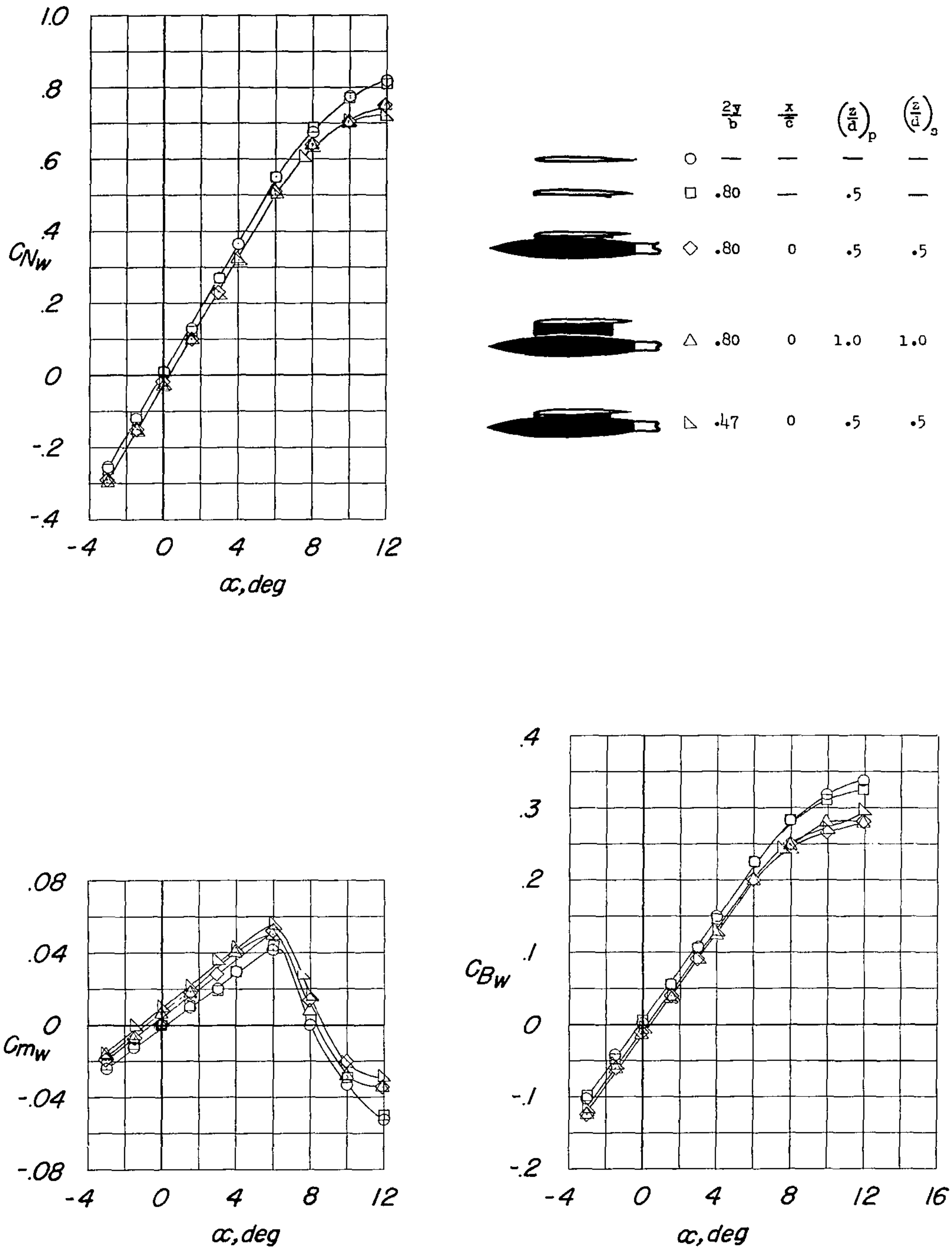
Figure 8.- Continued.



(g) M = 1.96.

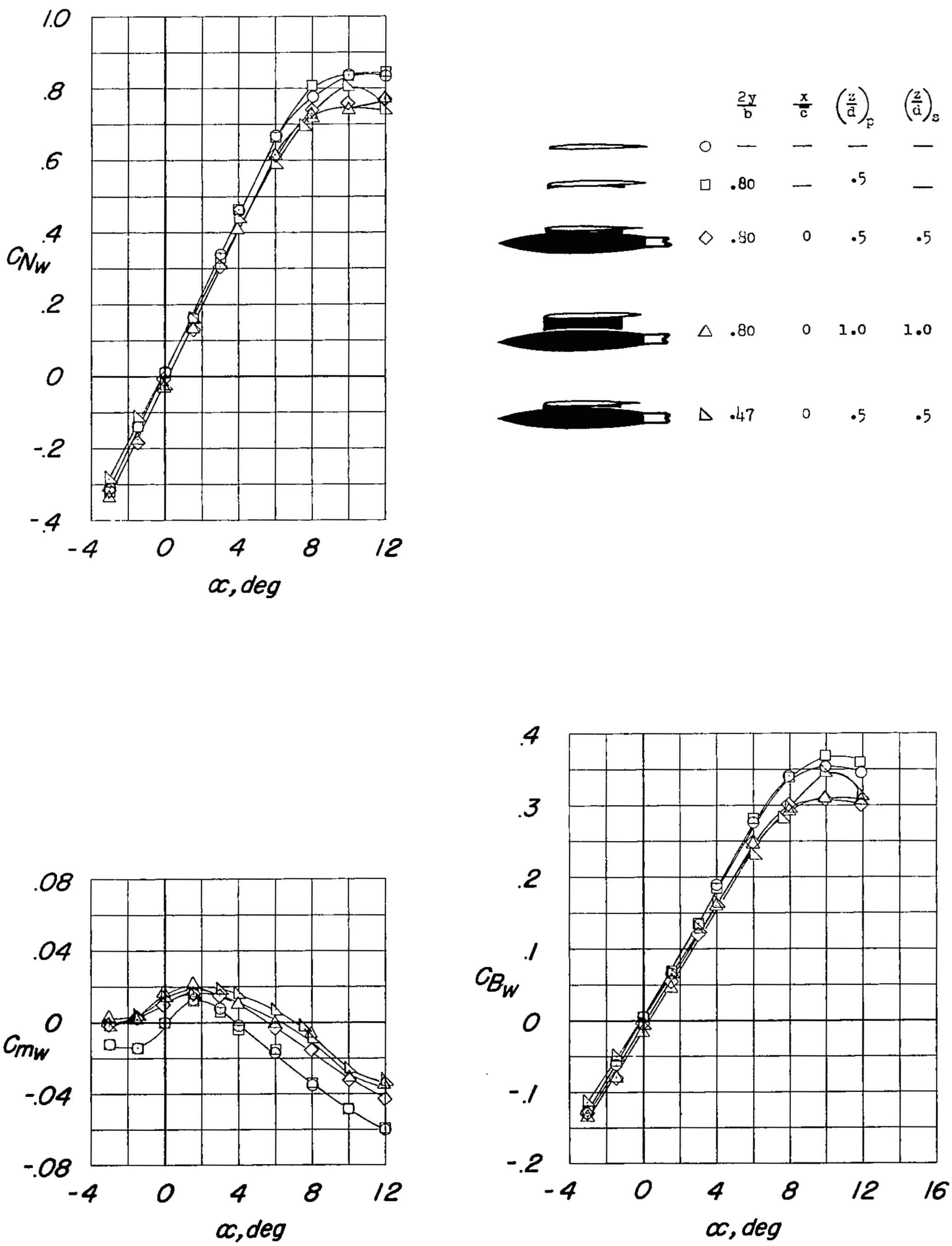
Figure 8.- Concluded.

[redacted]



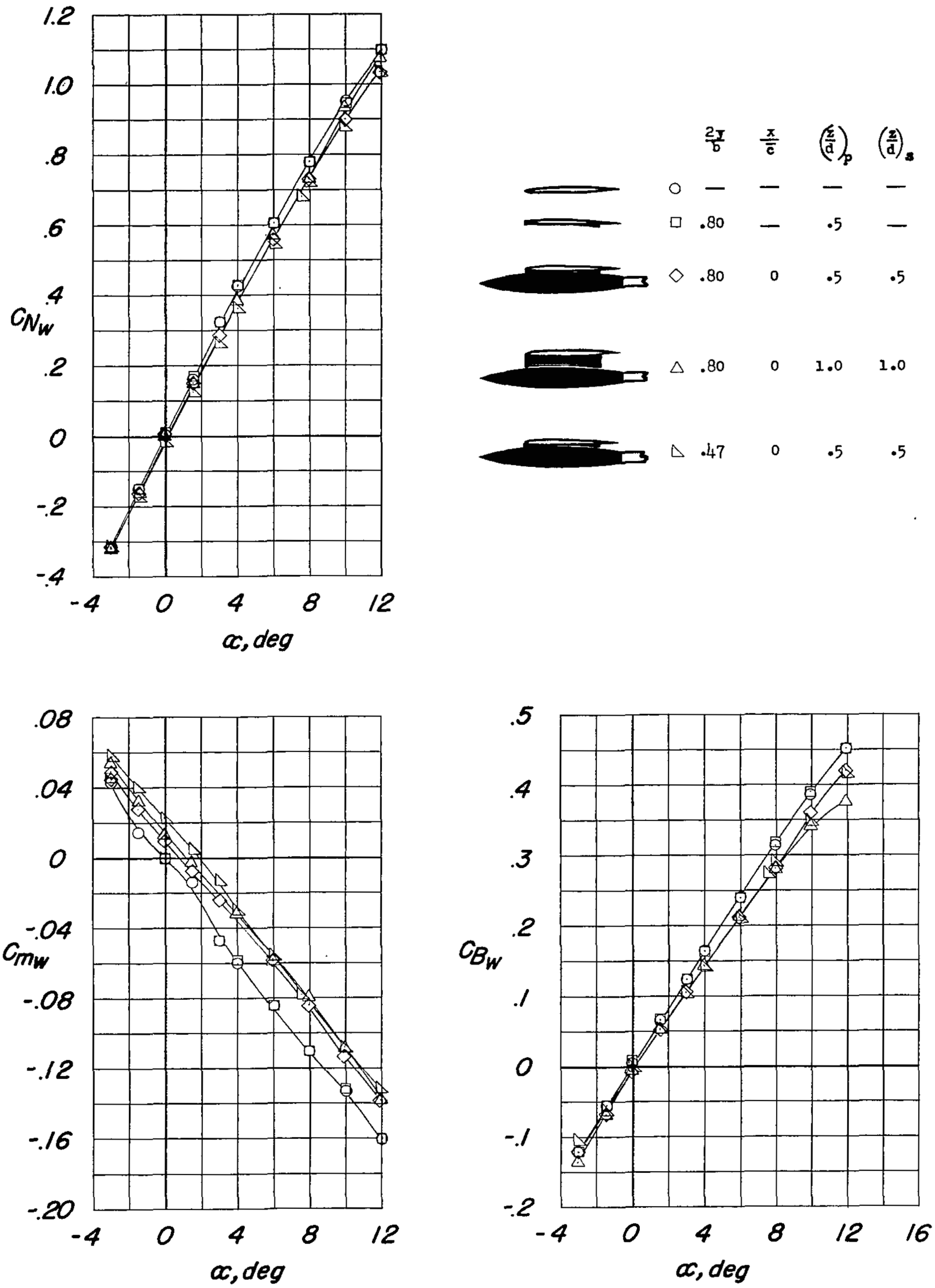
(a) M = 0.75.

Figure 9.- Influence of DAC store at two vertical positions and of short pylon on aerodynamic characteristics of wing-fuselage (2y/b = 0.80) compared with influence of store at 2y/b = 0.47. Original fuselage.



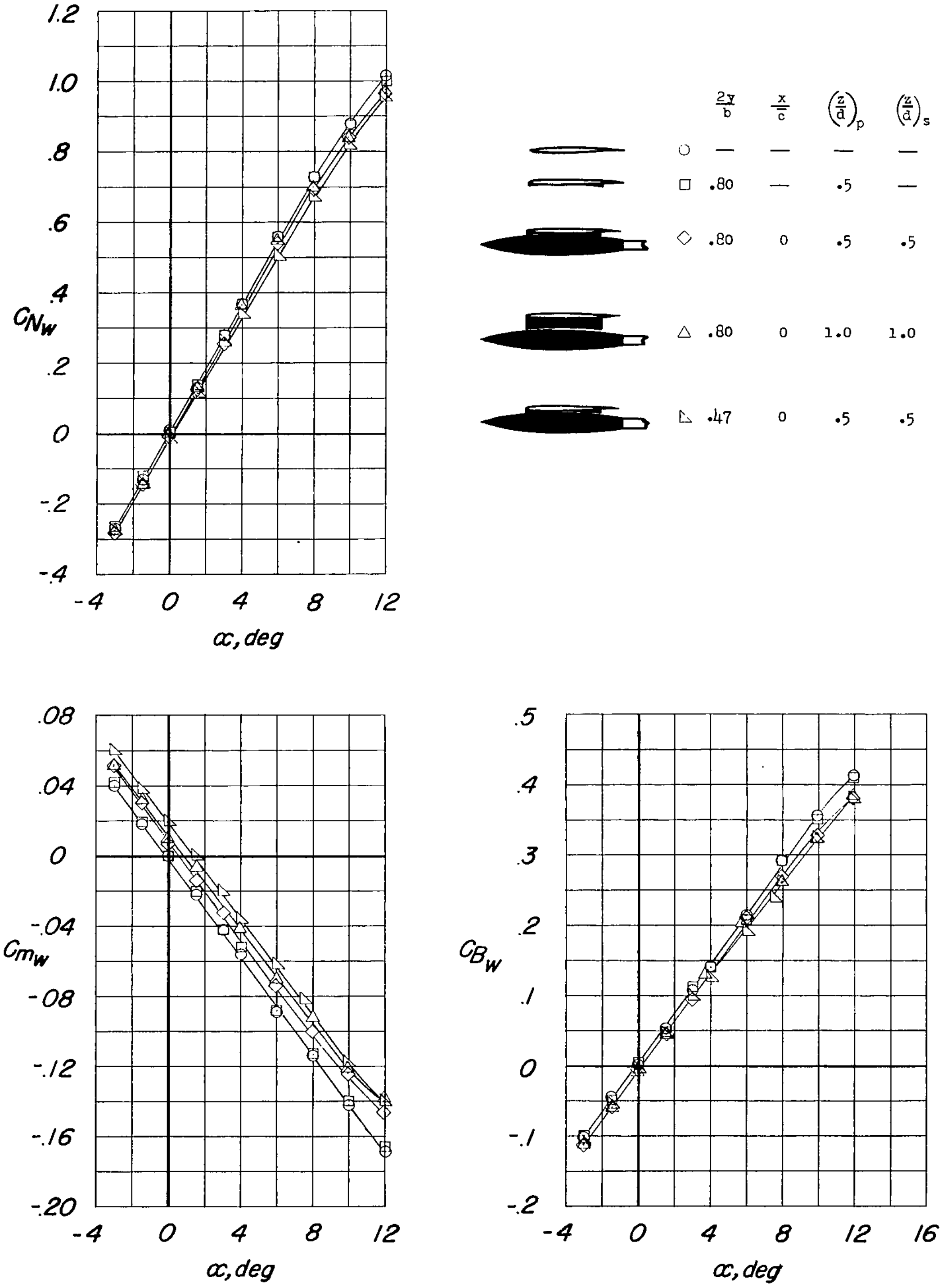
(b) M = 0.90.

Figure 9.- Continued.



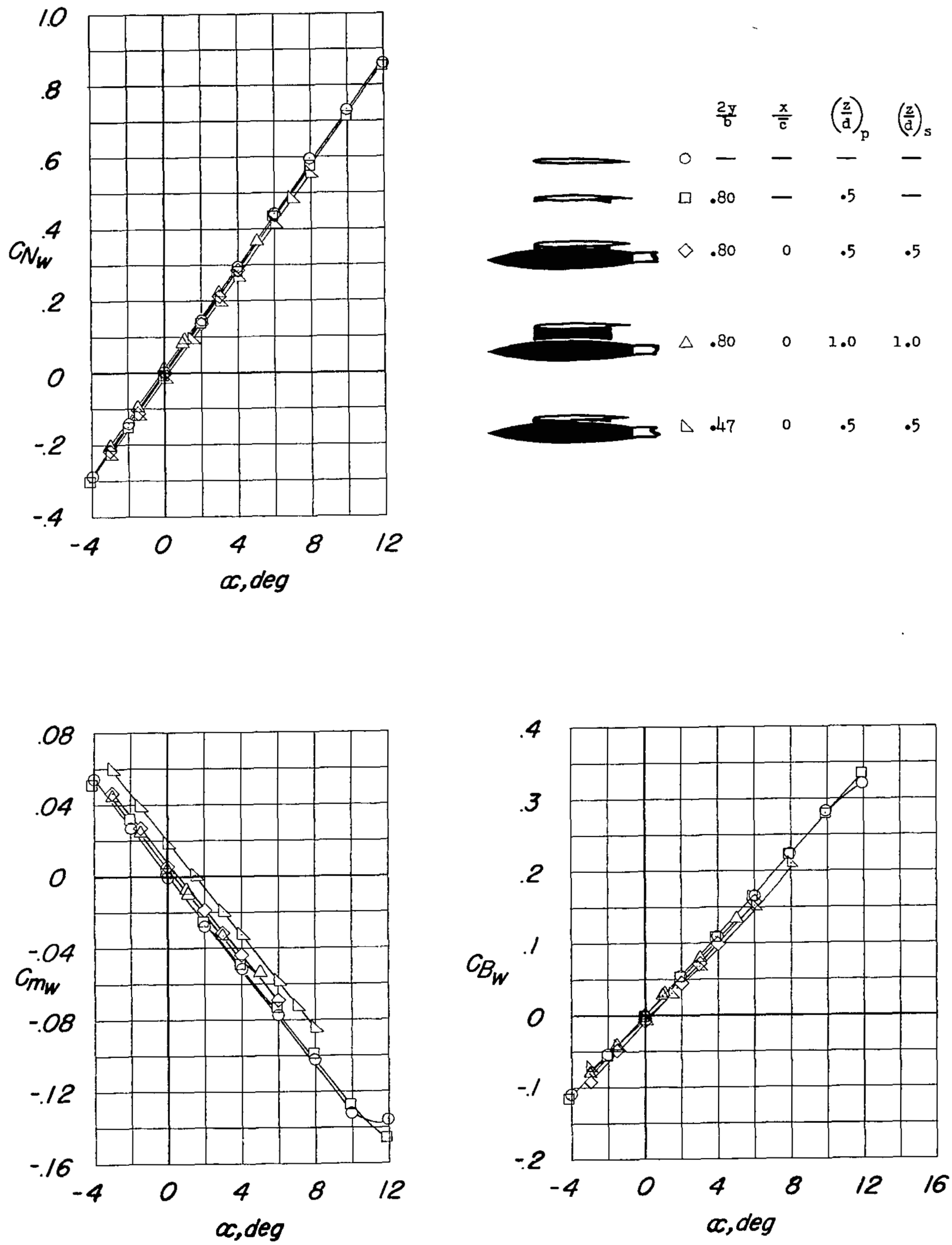
(c) M = 1.05.

Figure 9.- Continued.



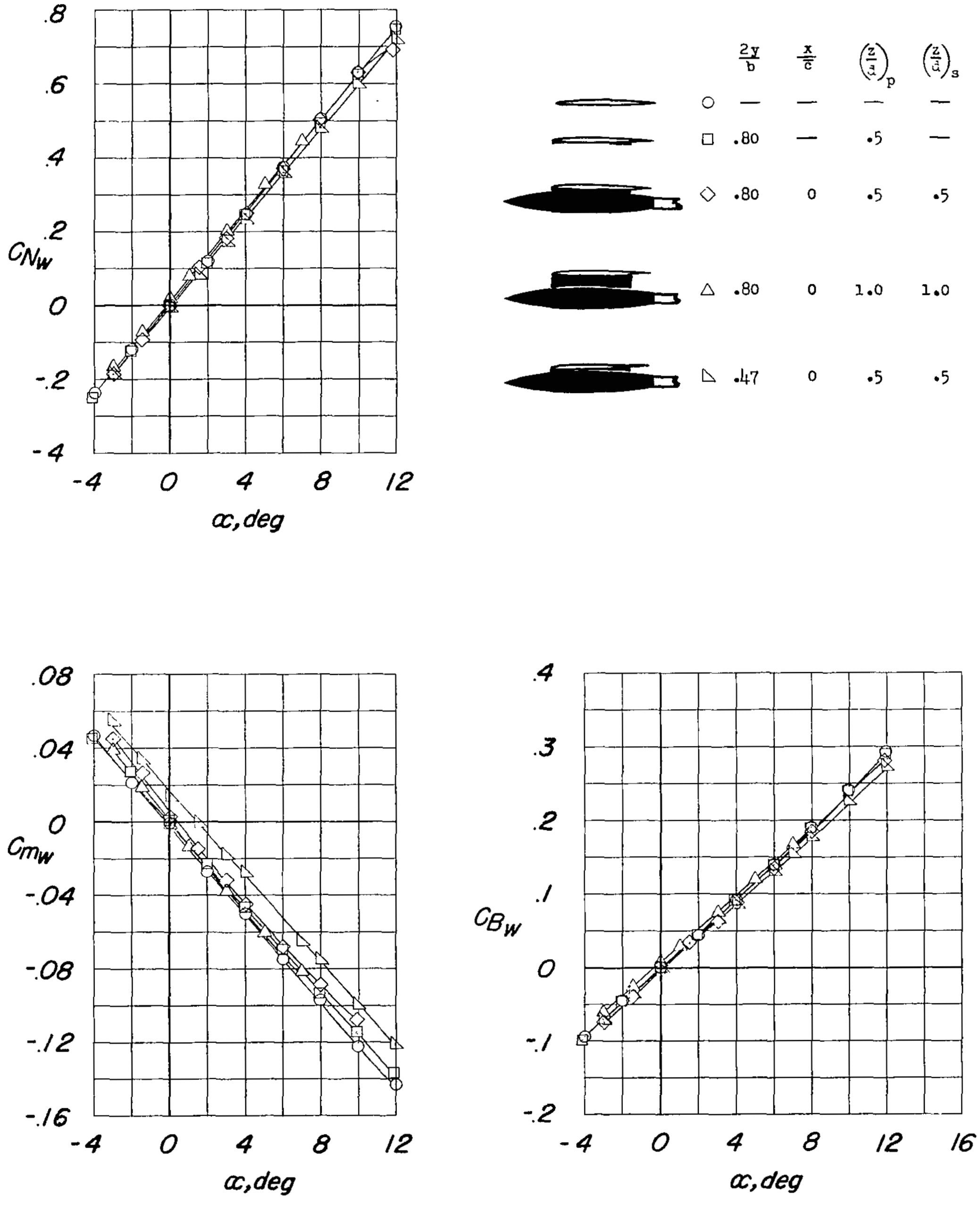
(d) M = 1.20.

Figure 9.- Continued.



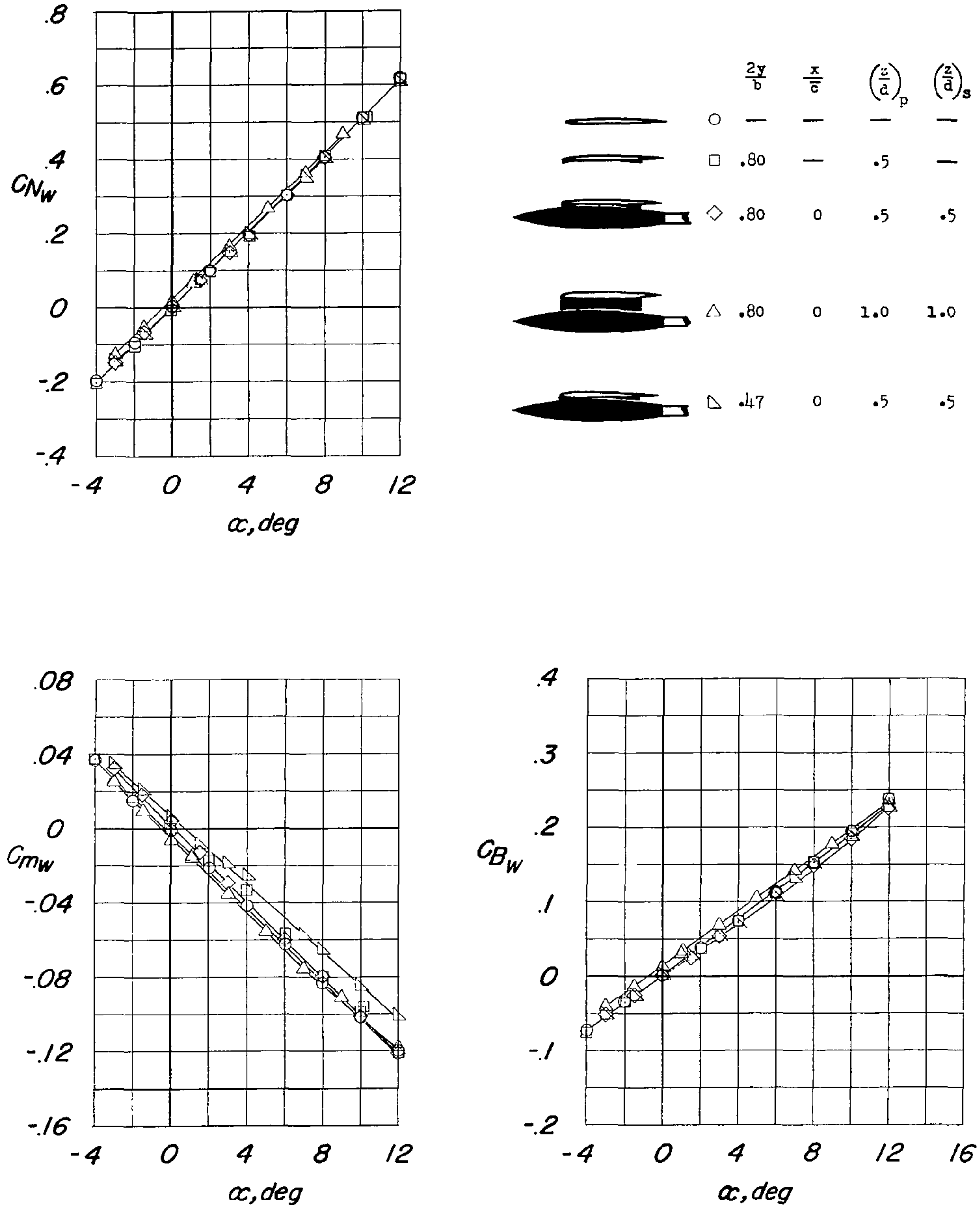
(e) M = 1.41.

Figure 9.- Continued.



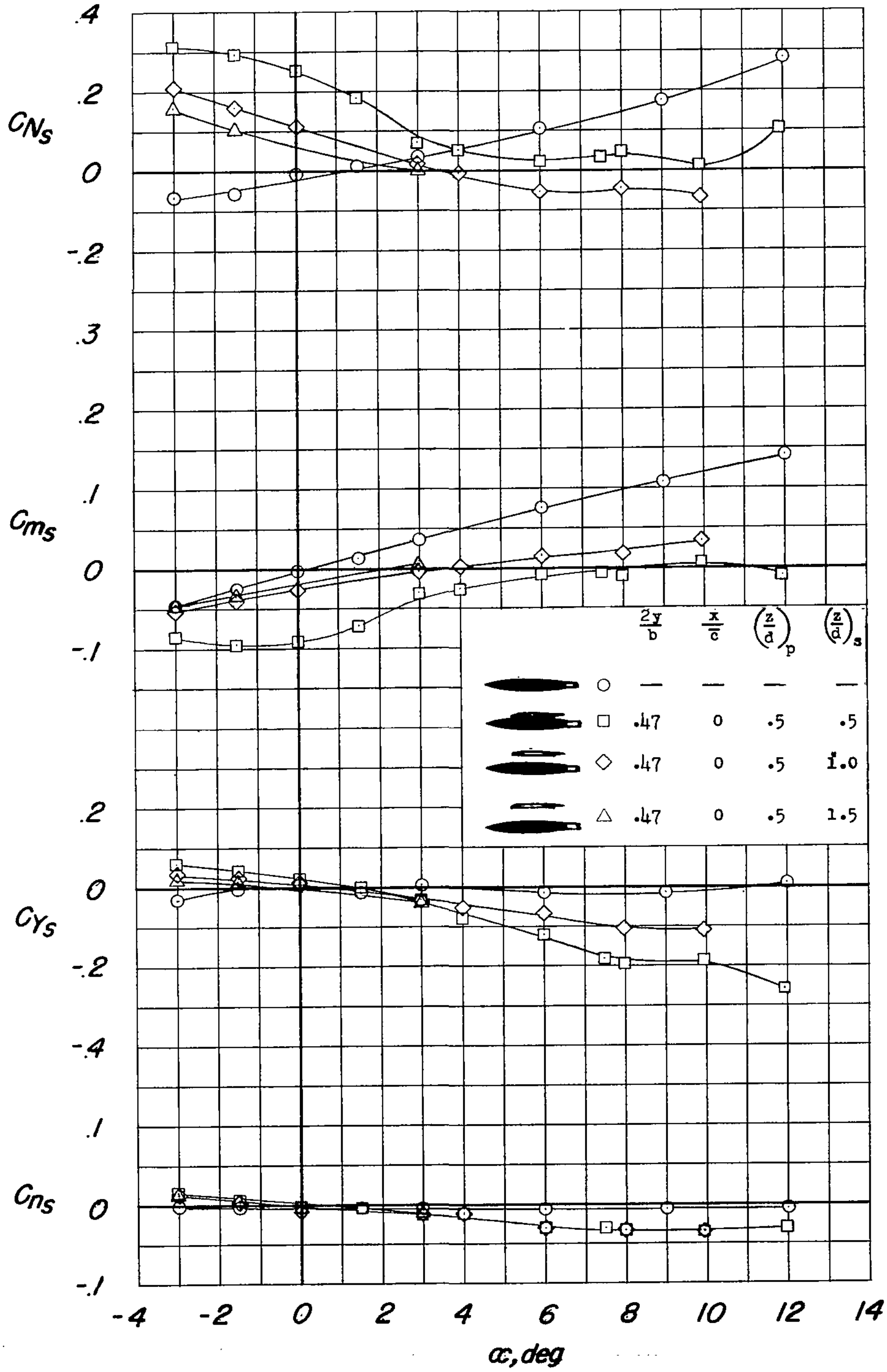
(f) M = 1.62.

Figure 9.- Continued.



(g) M = 1.96.

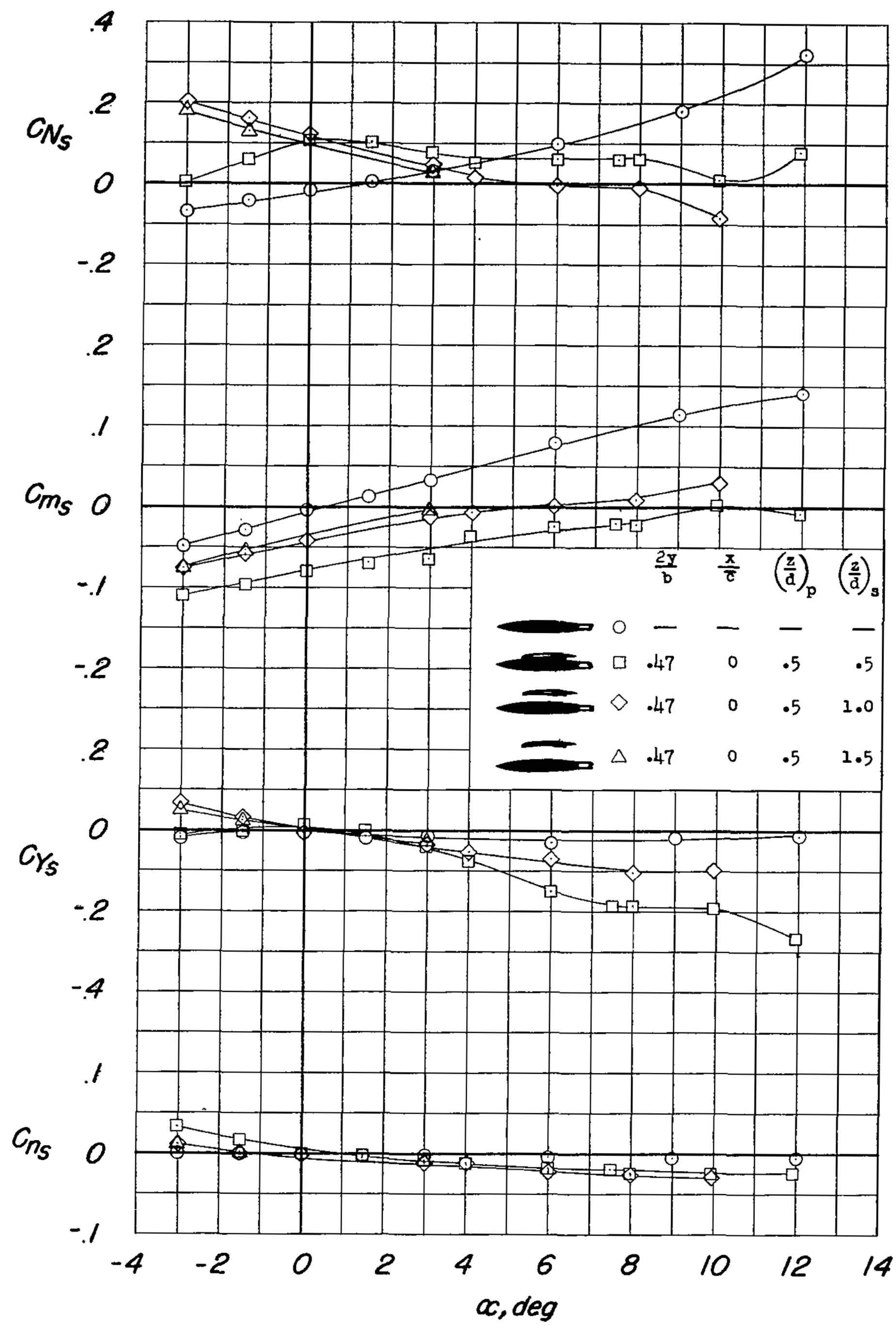
Figure 9.- Concluded.



(a) M = 0.75.

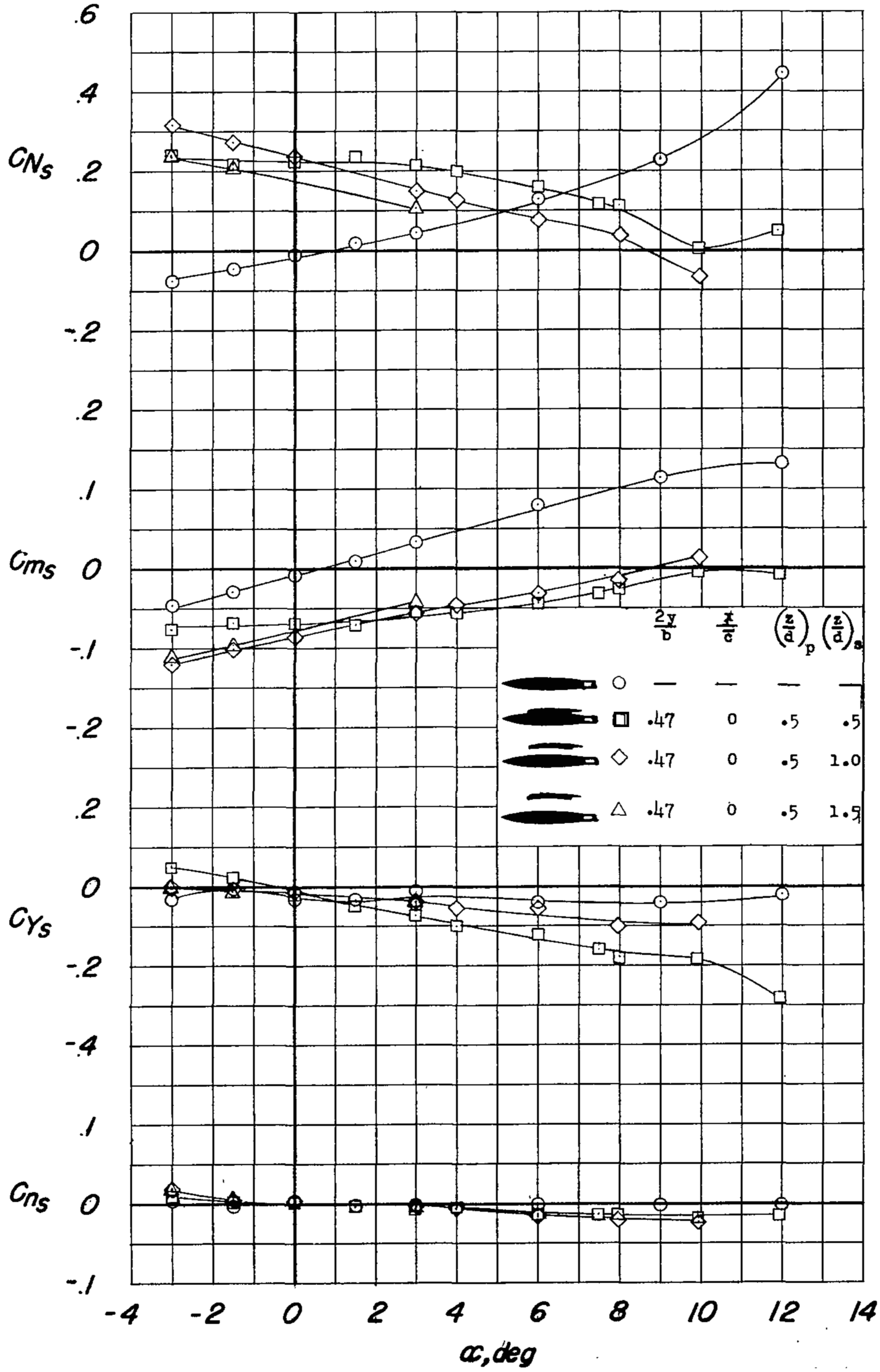
Figure 10.- Aerodynamic characteristics of DAC store at varying vertical distances from wing at 2y/b = 0.47. Original fuselage.

[redacted]



(b) M = 0.90.

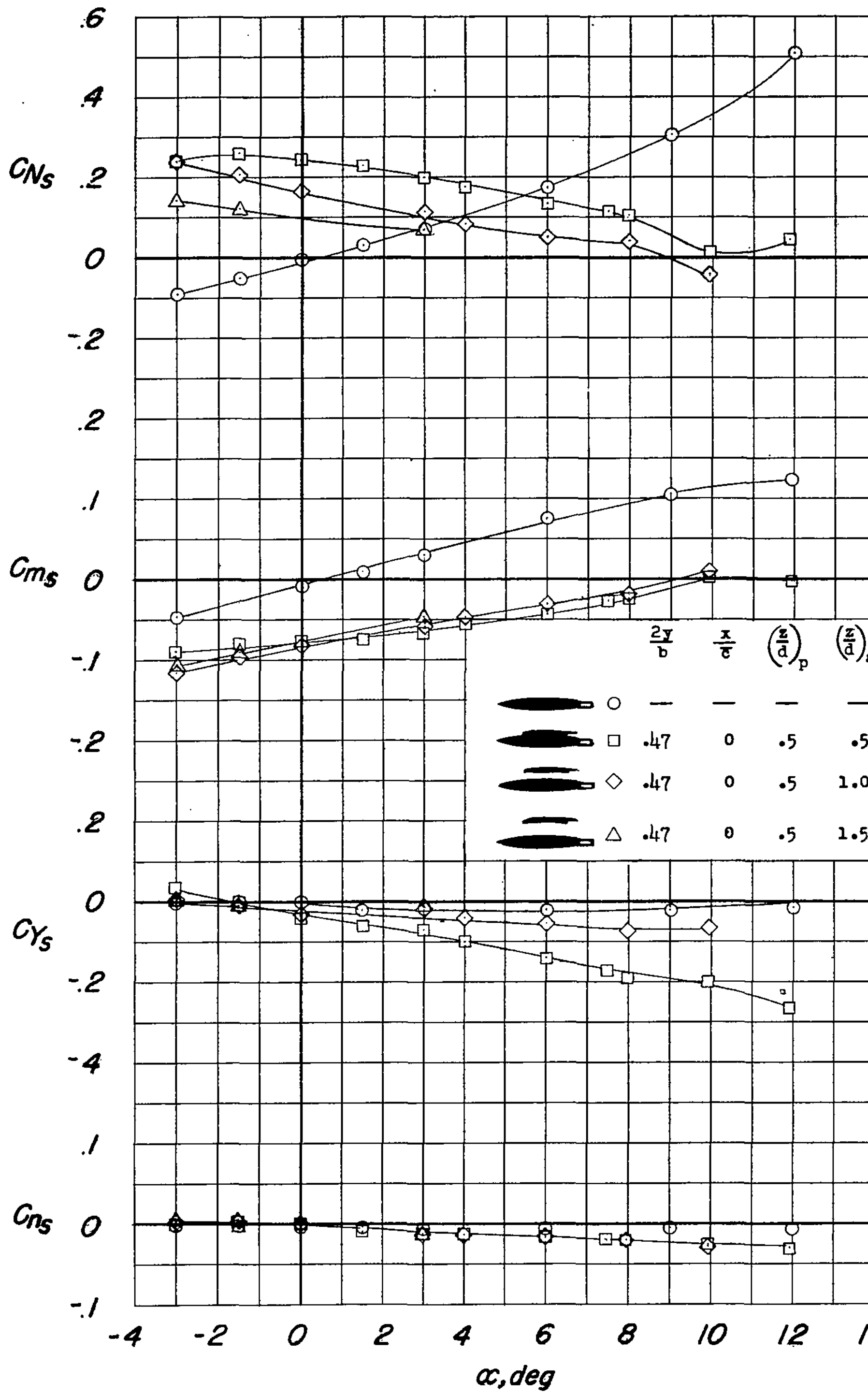
Figure 10.- Continued.



(c) M = 1.05.

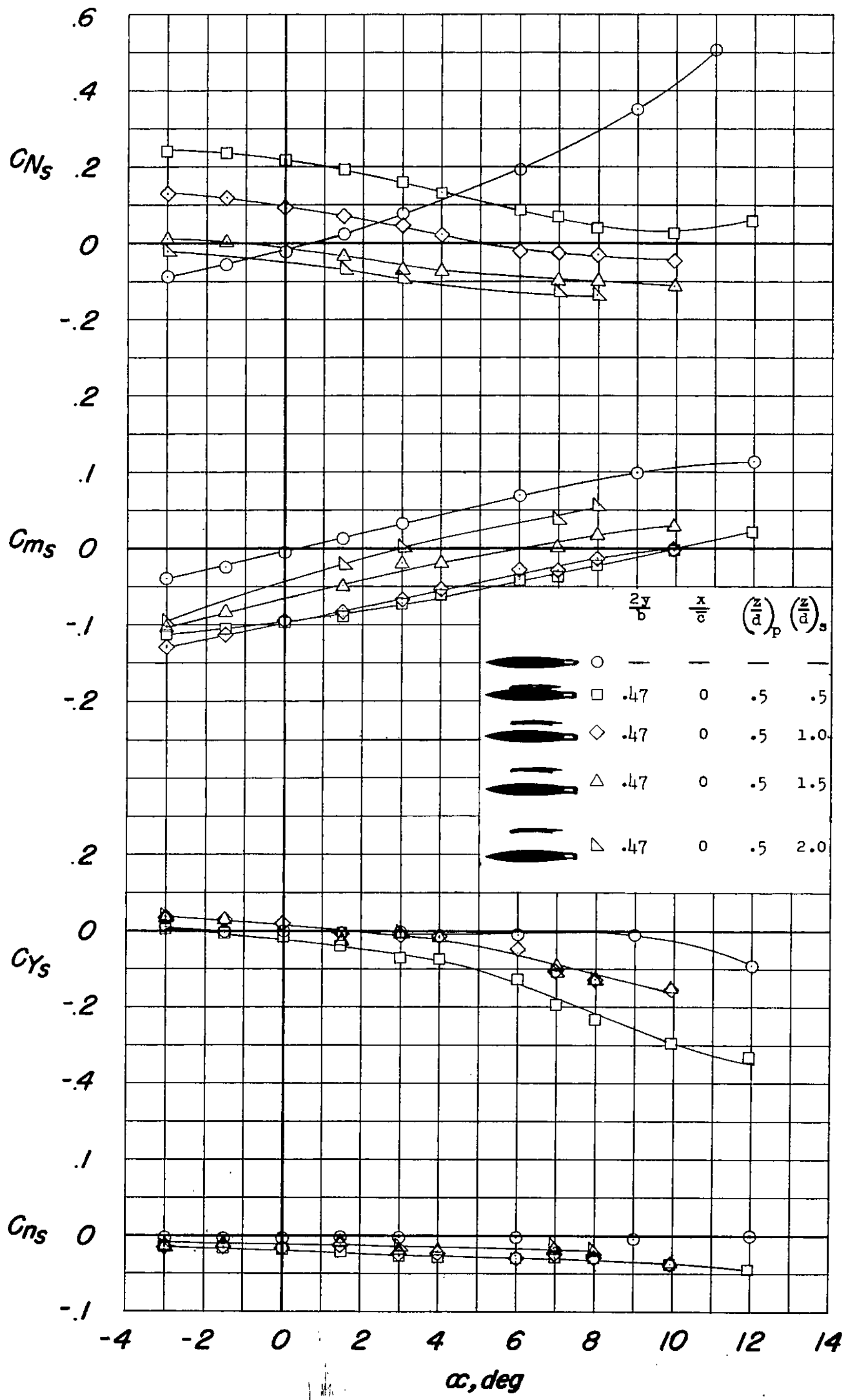
Figure 10.- Continued.

[redacted]



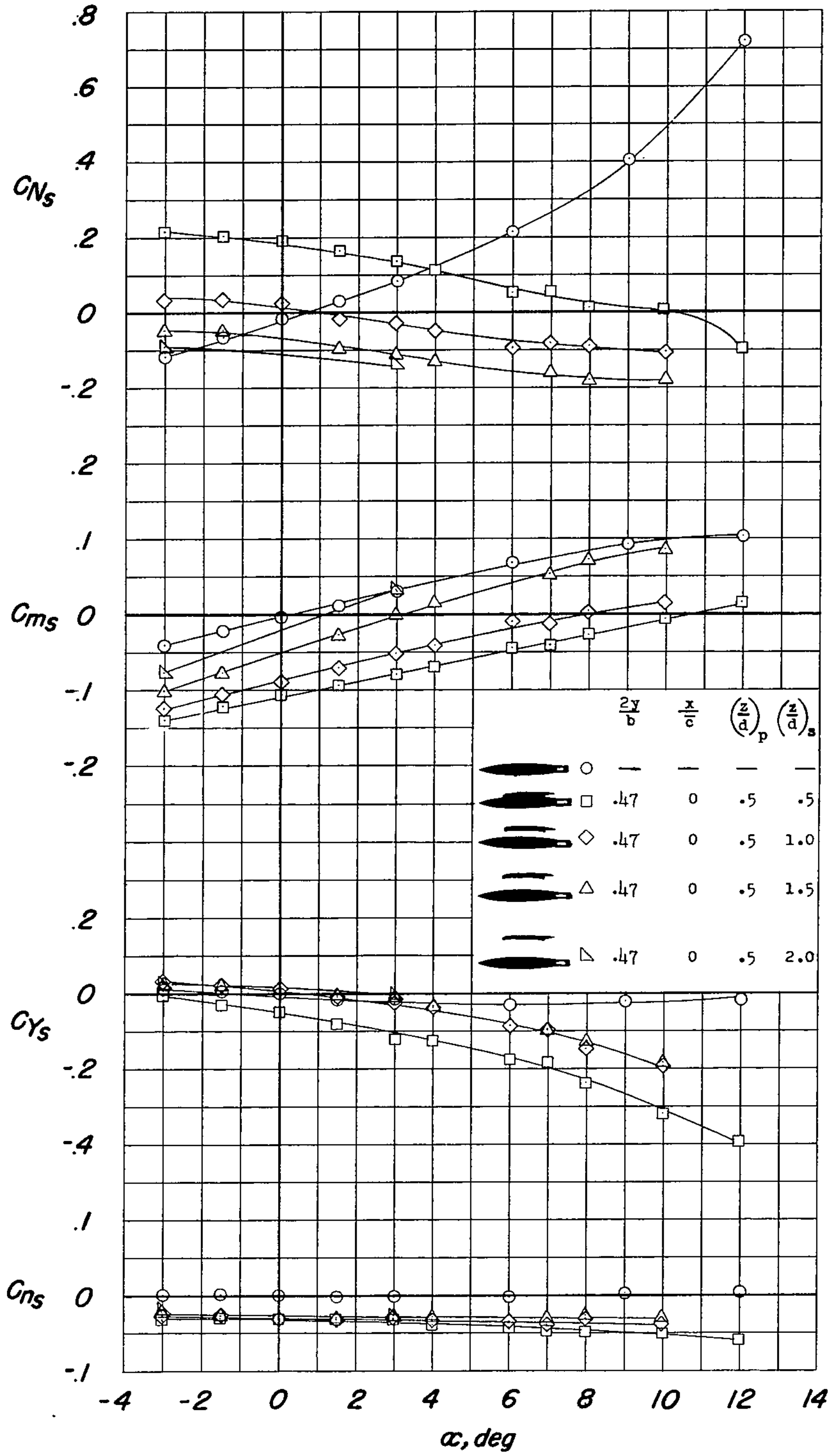
(d) M = 1.20.

Figure 10.- Continued.



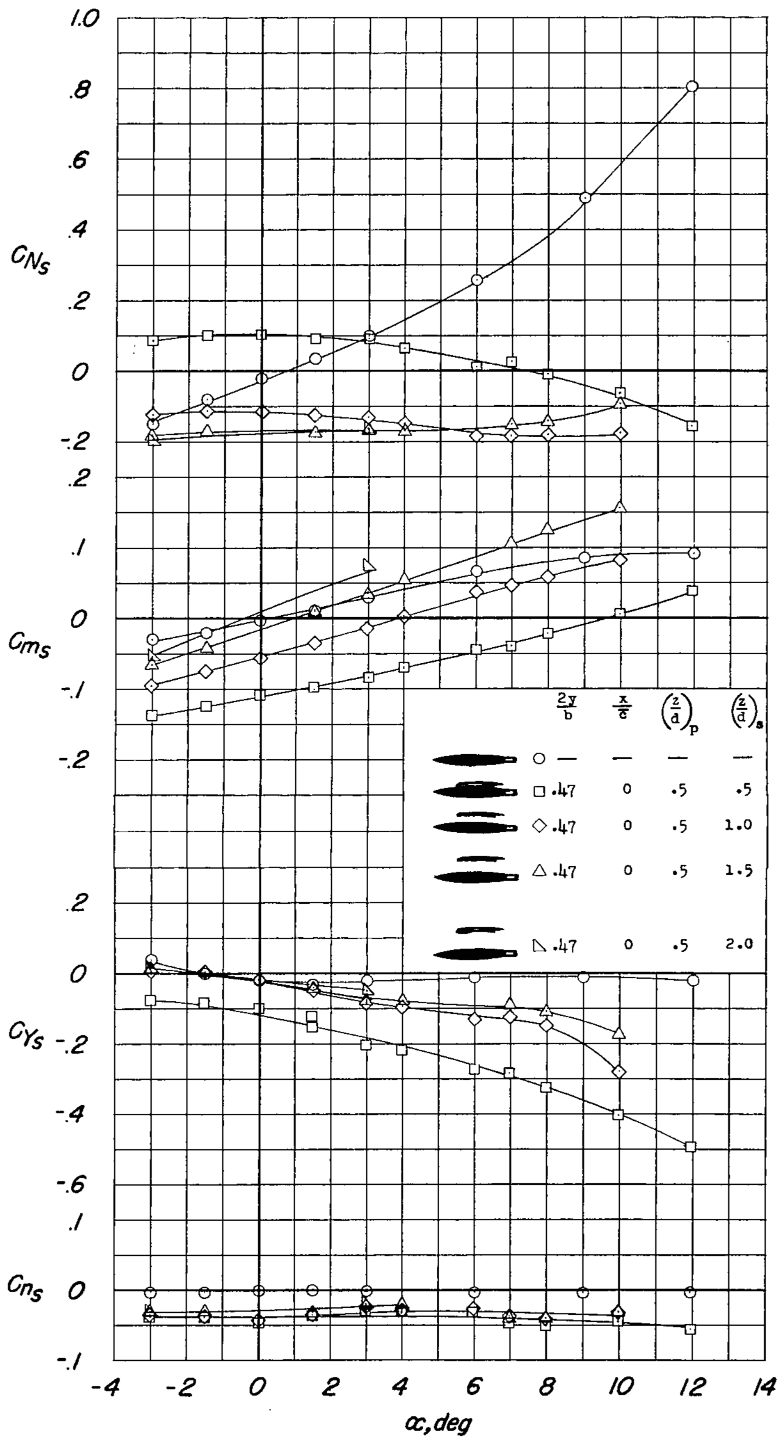
(e) M = 1.41.

Figure 10.- Continued.



(f) M = 1.62.

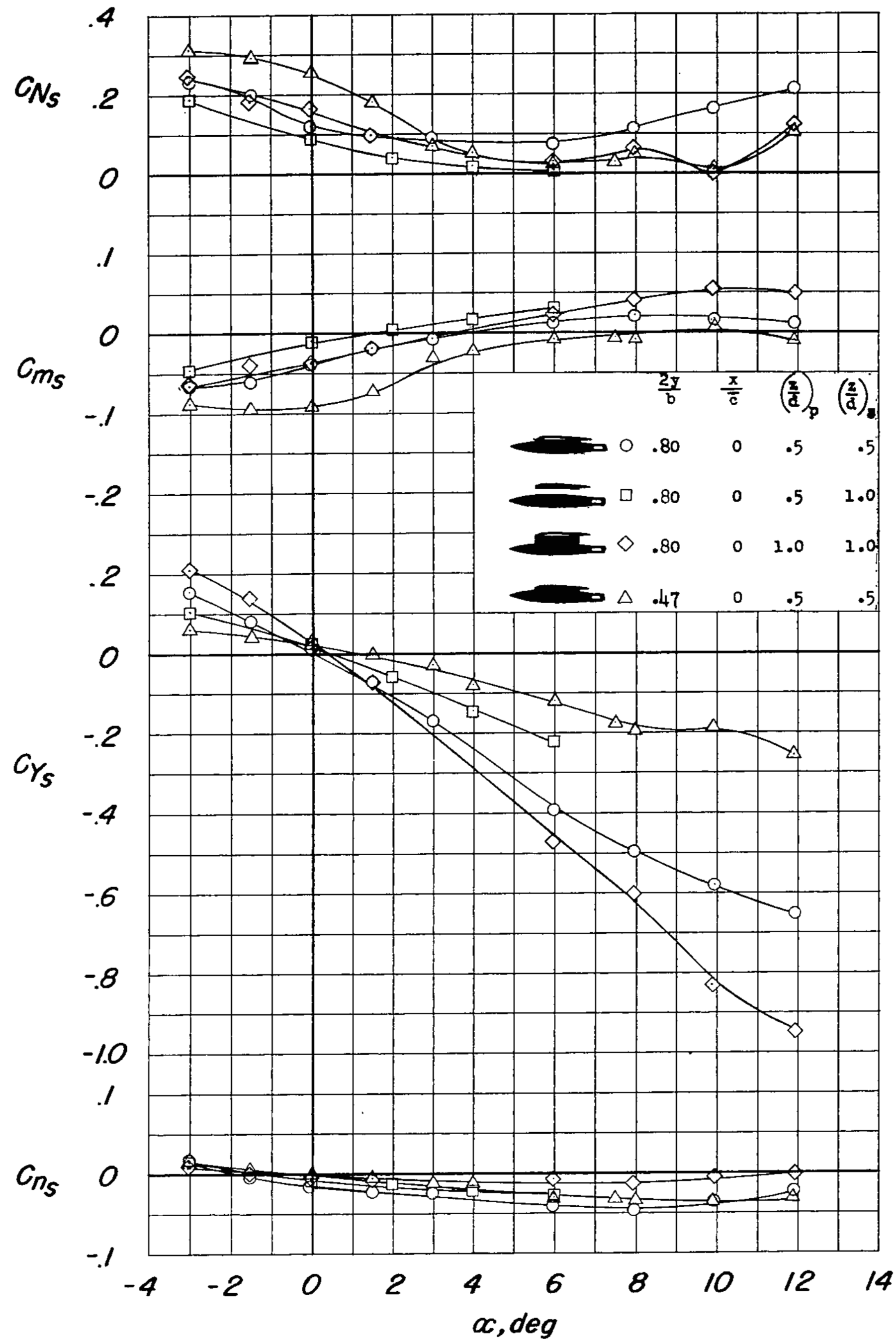
Figure 10.- Continued.



(g) M = 1.96.

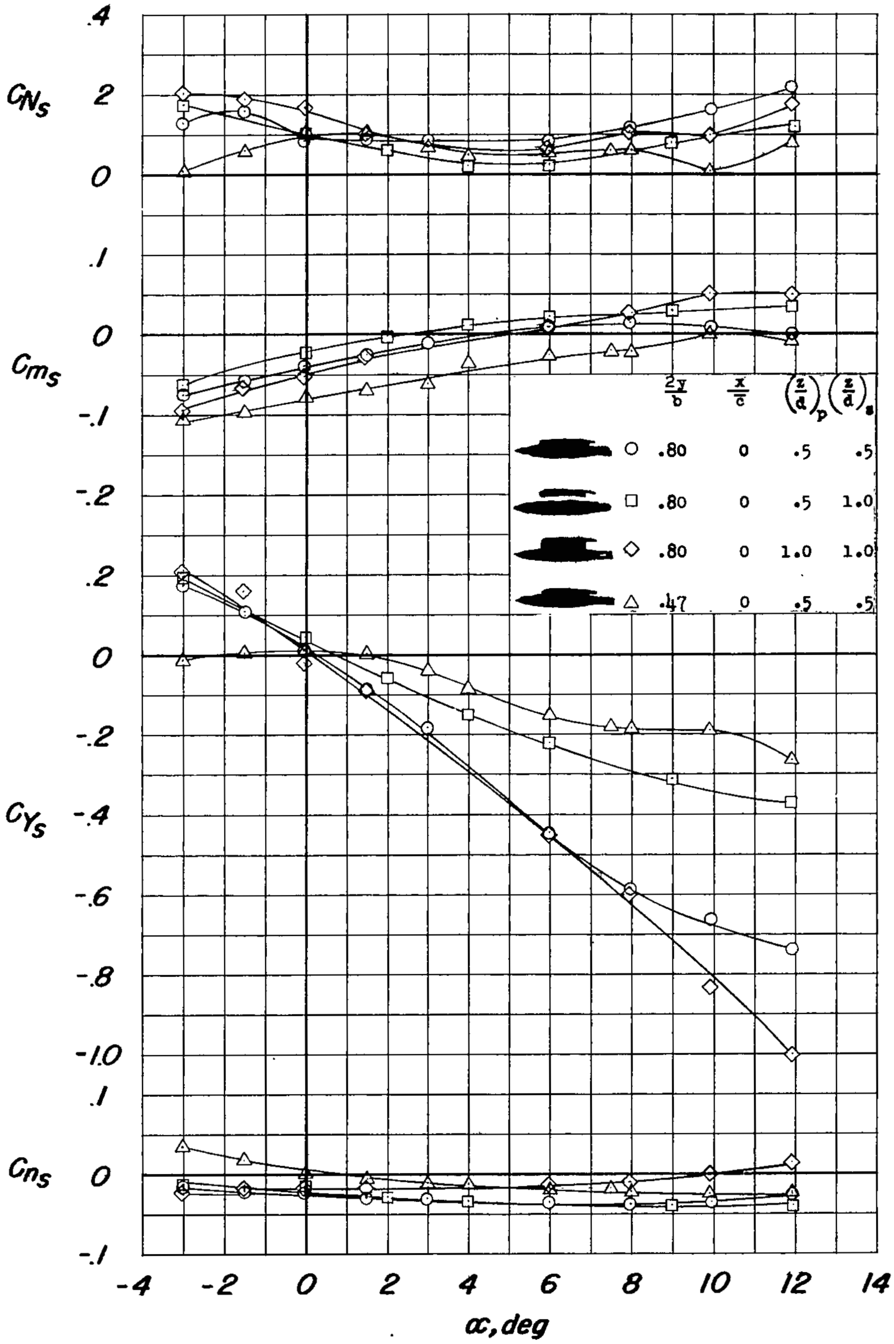
Figure 10.- Concluded.

[redacted]



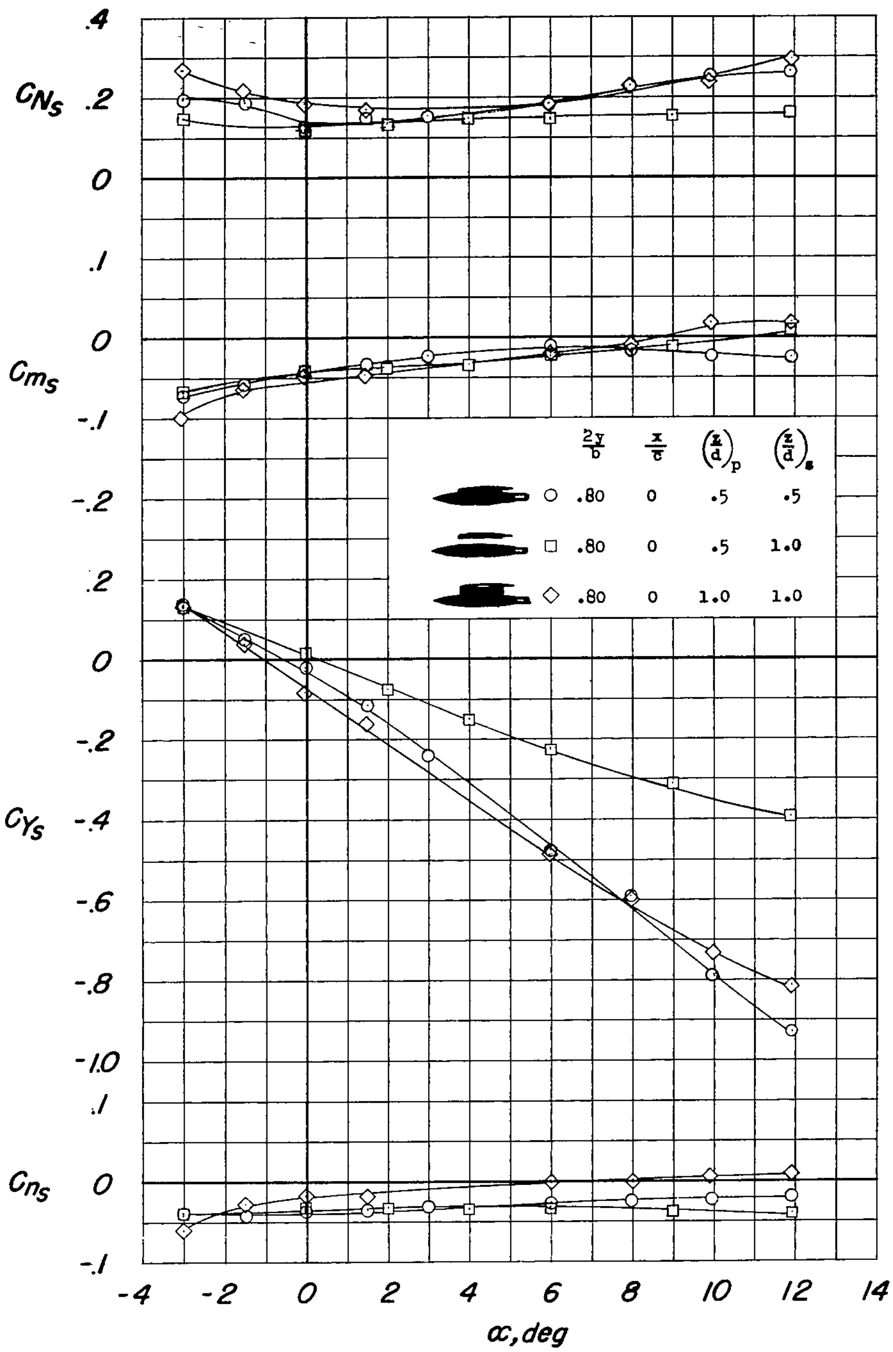
(a) M = 0.75.

Figure 11.- Aerodynamic characteristics of DAC store at two vertical positions relative to wing, including effects of pylon (2y/b = 0.80) compared with store characteristics at 2y/b = 0.47. Original fuselage.



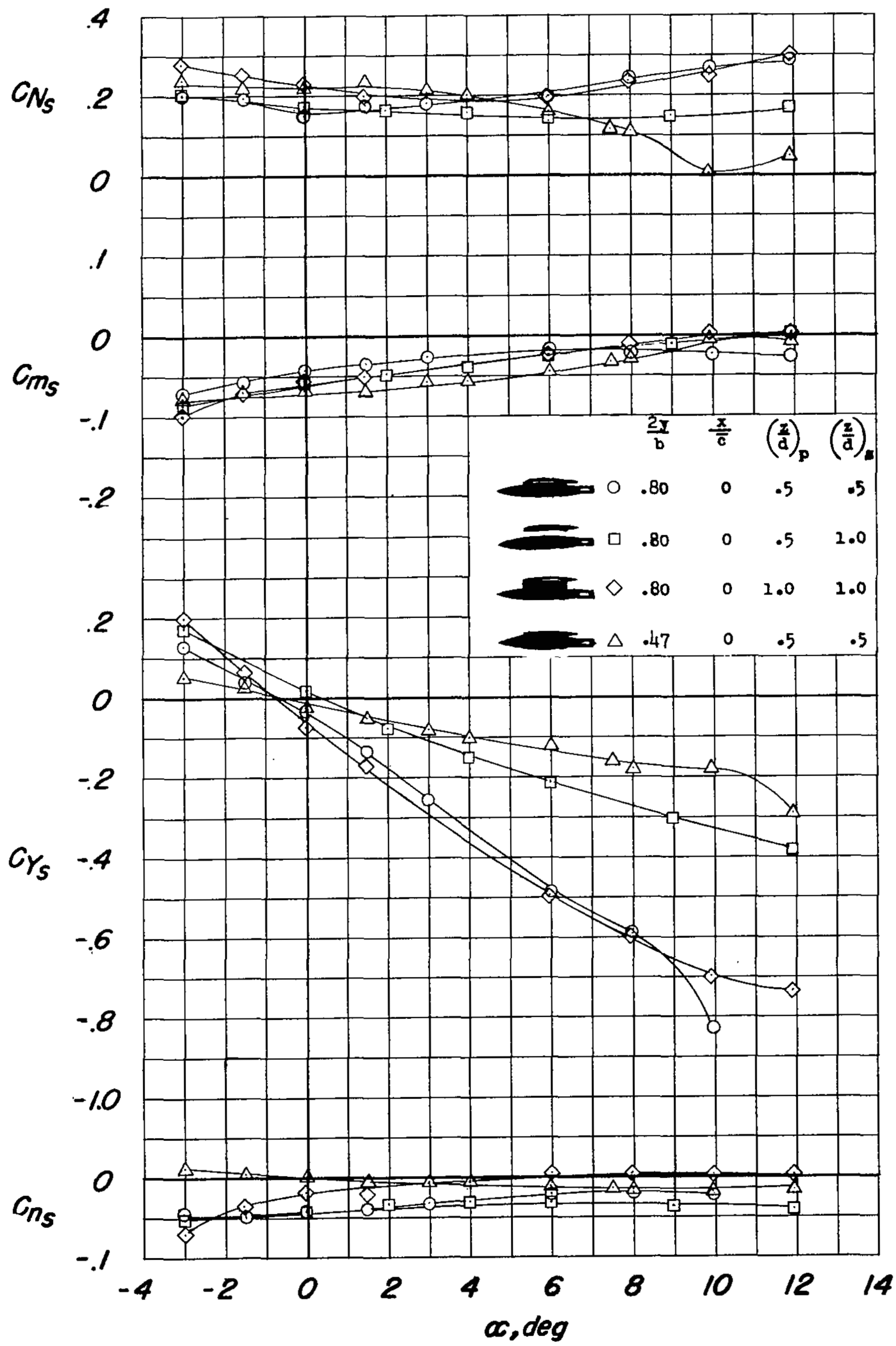
(b) M = 0.90.

Figure 11.- Continued.



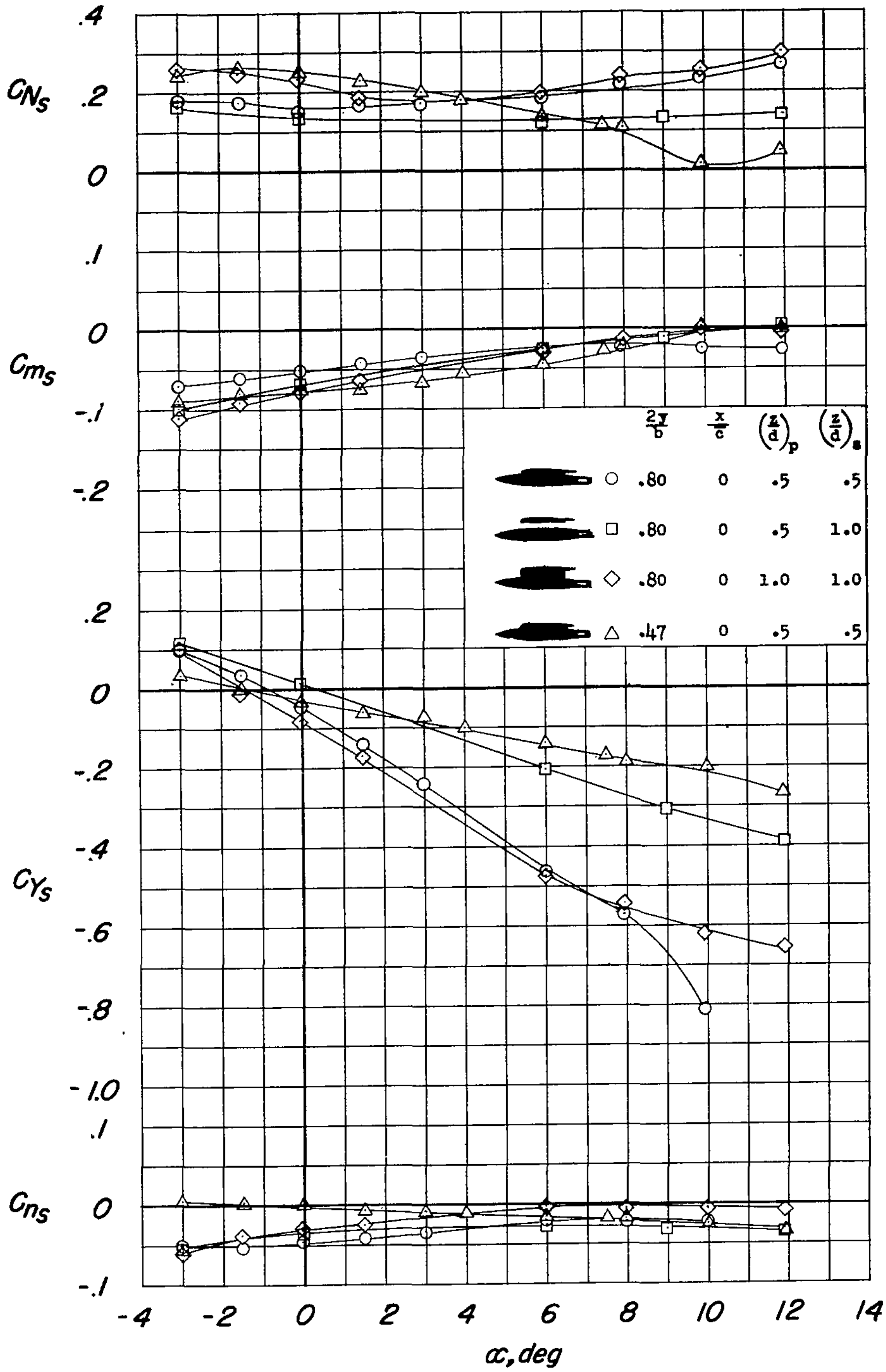
(c) M = 1.00.

Figure 11.- Continued.



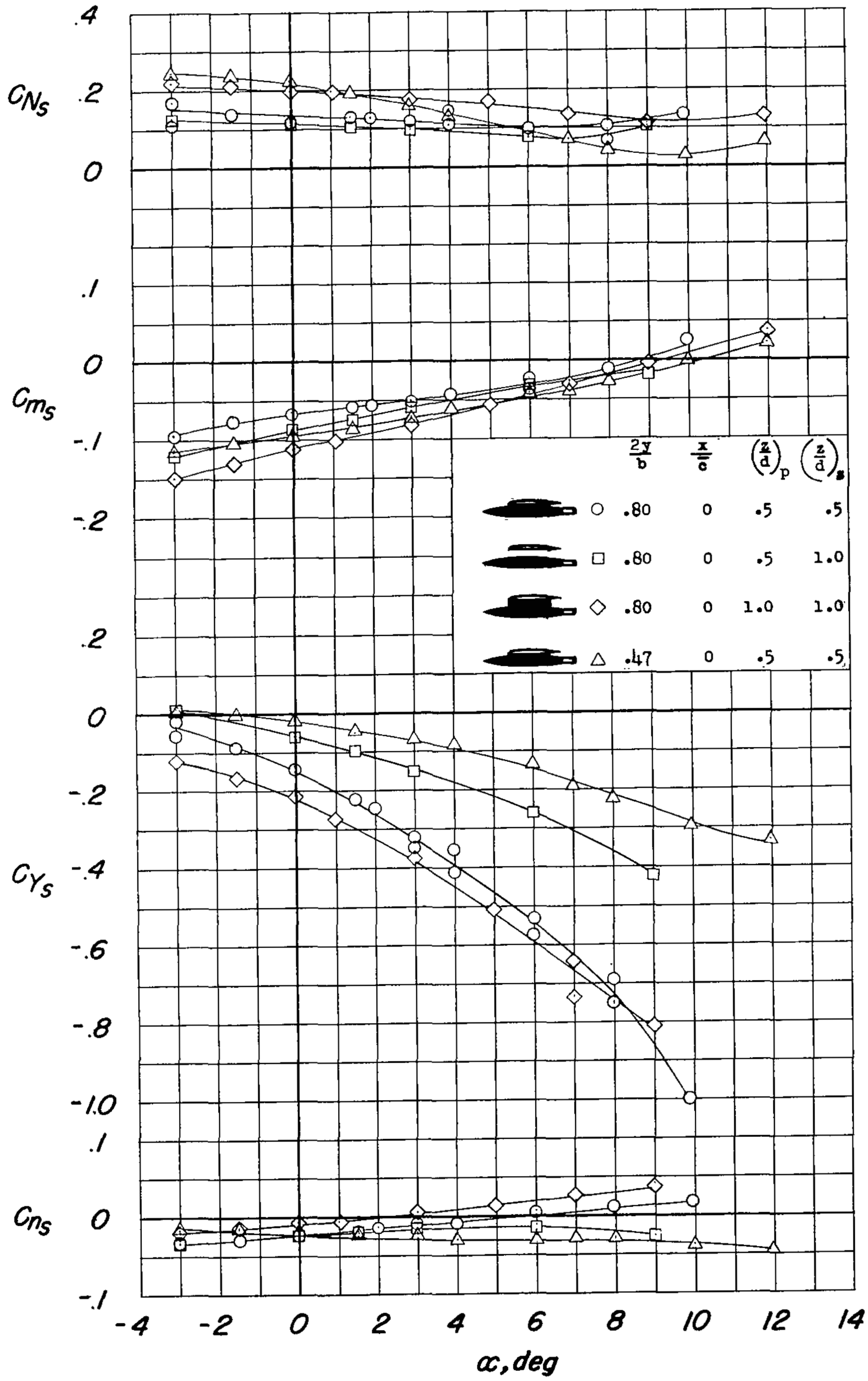
(d) M = 1.05.

Figure 11.- Continued.



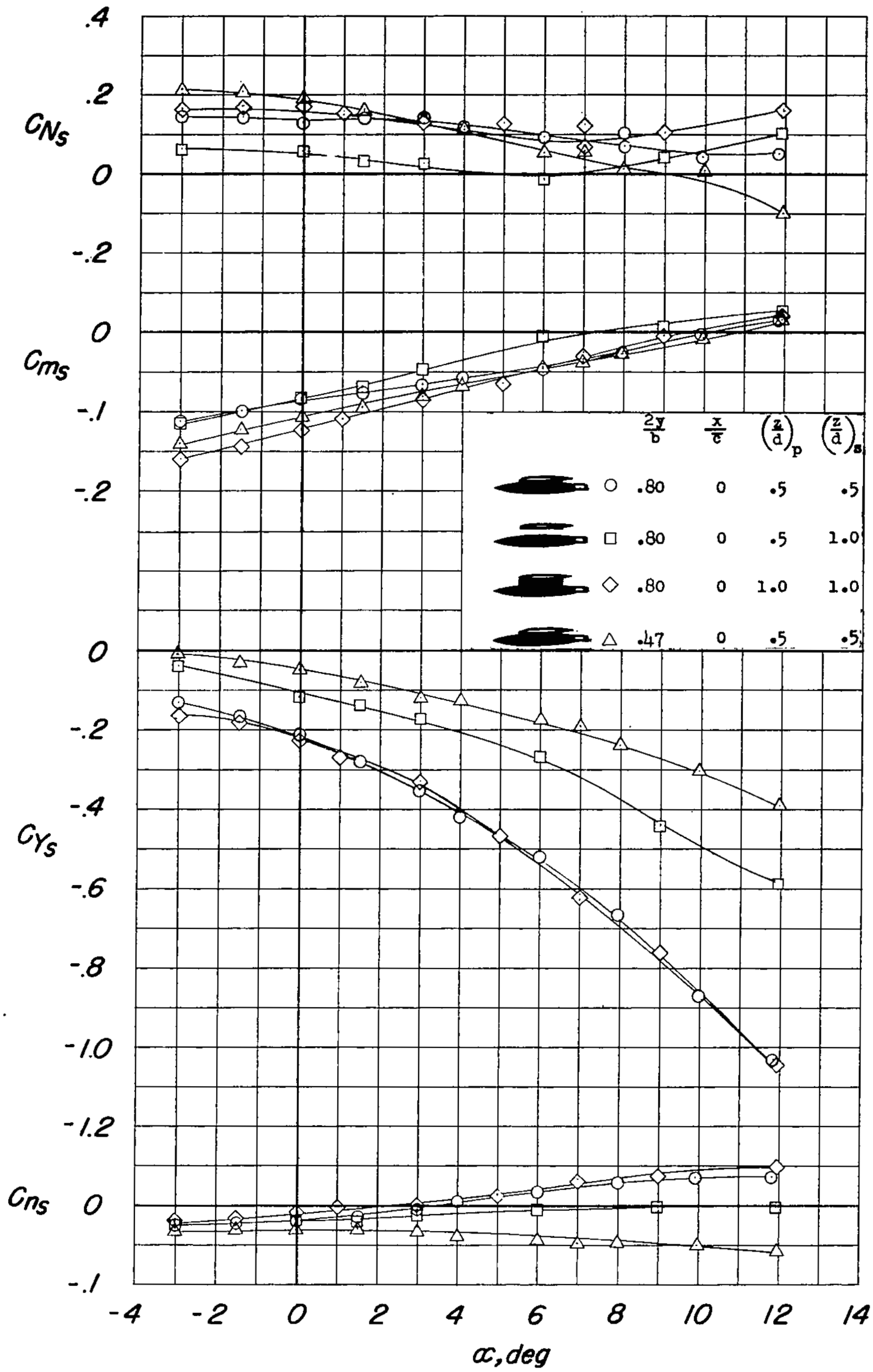
(e) M = 1.20.

Figure 11.- Continued.



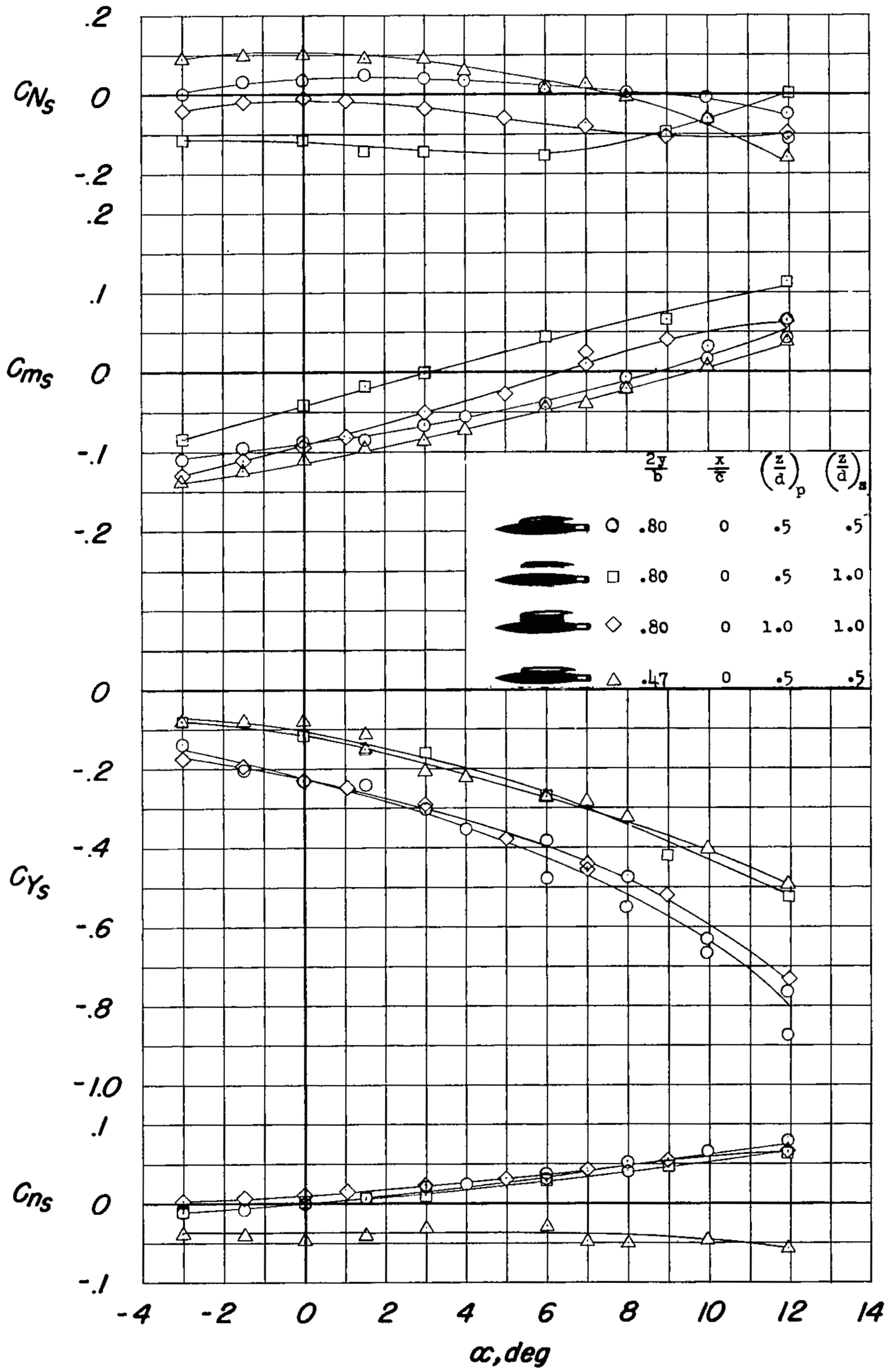
(f) M = 1.41.

Figure 11.- Continued.



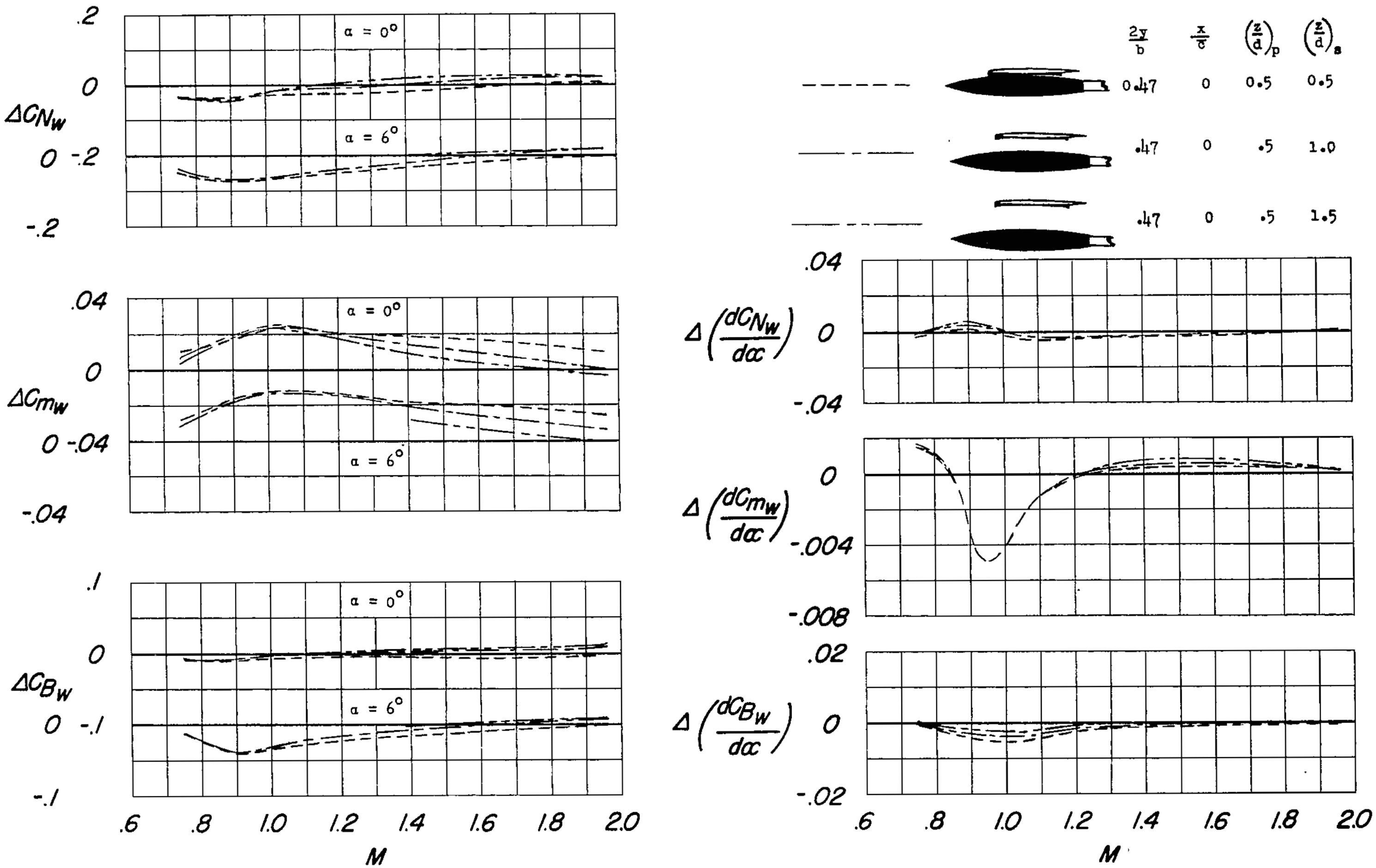
(g) M = 1.62.

Figure 11.- Continued.



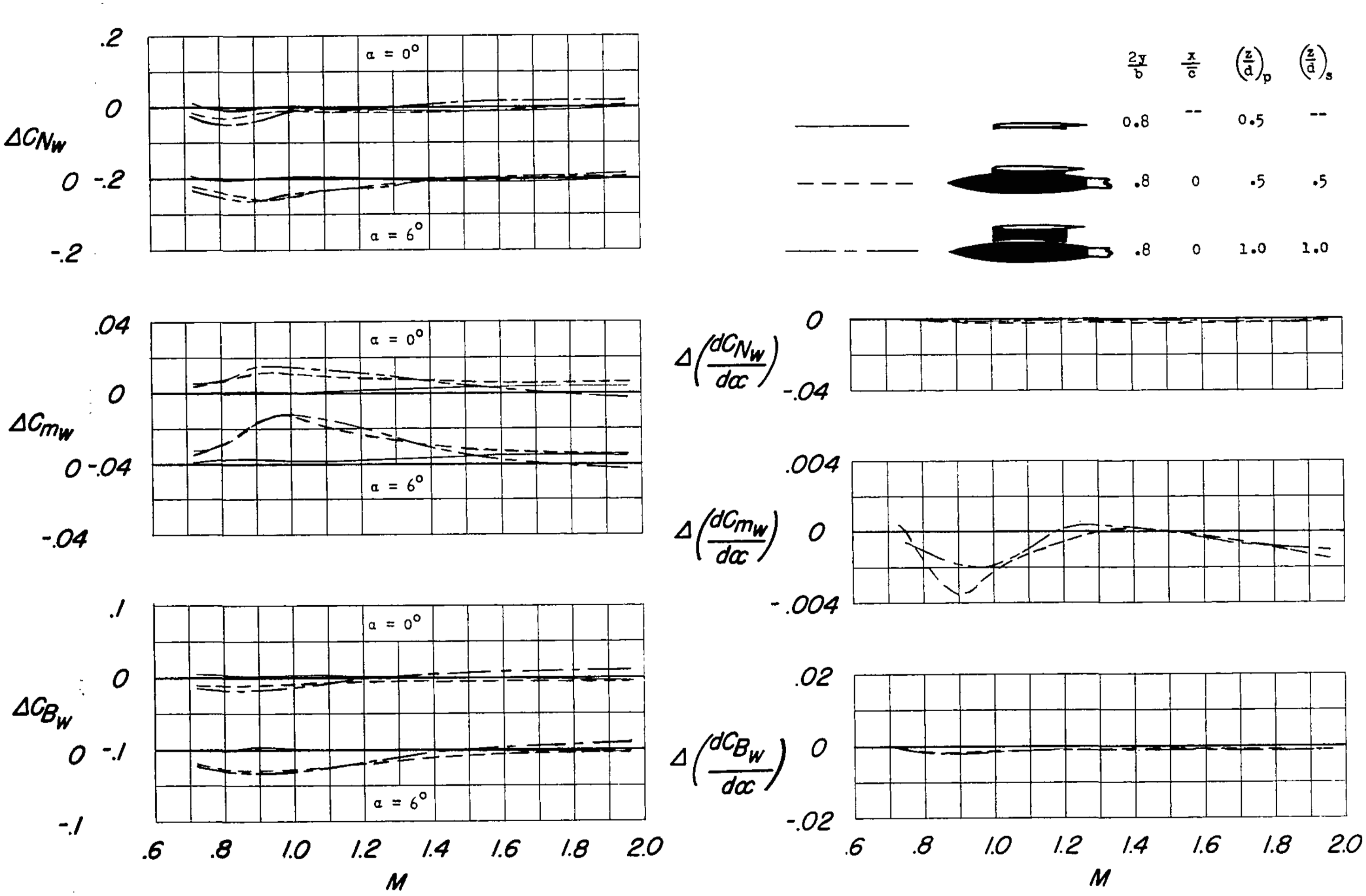
(h) M = 1.96.

Figure 11.- Concluded.



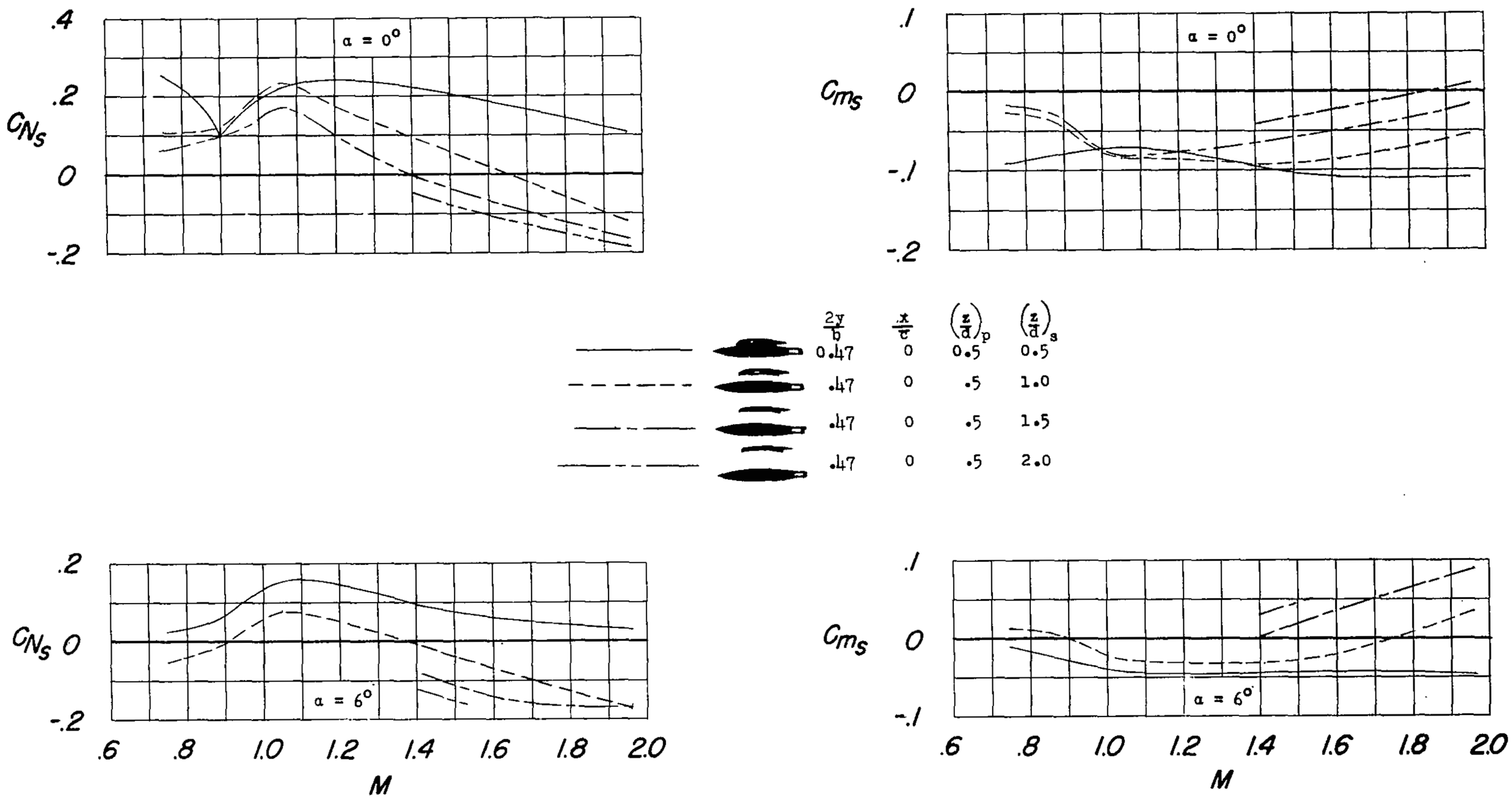
(a) Influence of vertical store position at 2y/b = 0.47.

Figure 12.- Variation with Mach number of the incremental wing force, moment and incremental slope changes due to the presence of the store at various vertical positions relative to the wing.



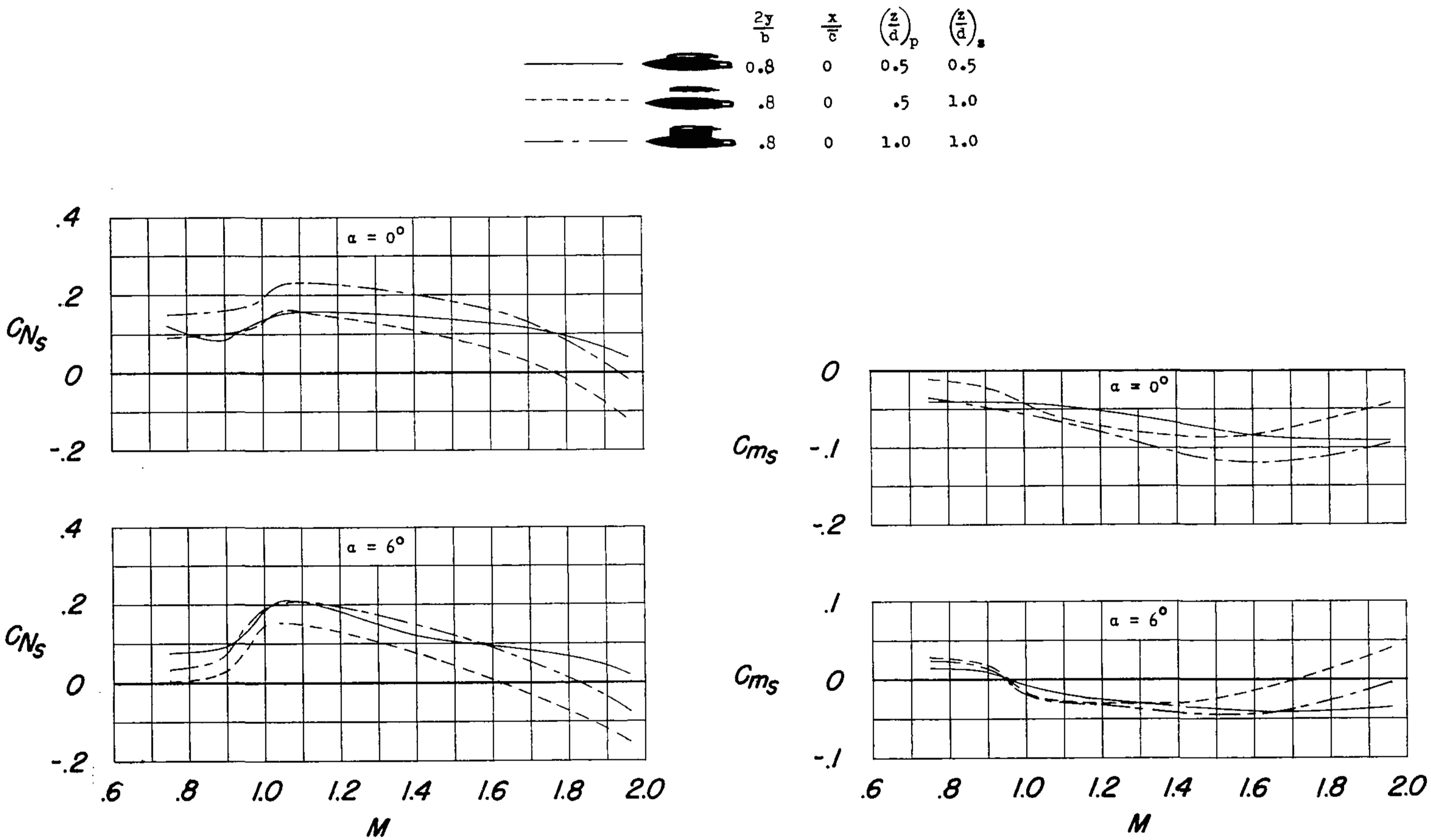
(b) Influence of vertical store position including effect of pylon at $2y/b = 0.80$.

Figure 12.- Concluded.



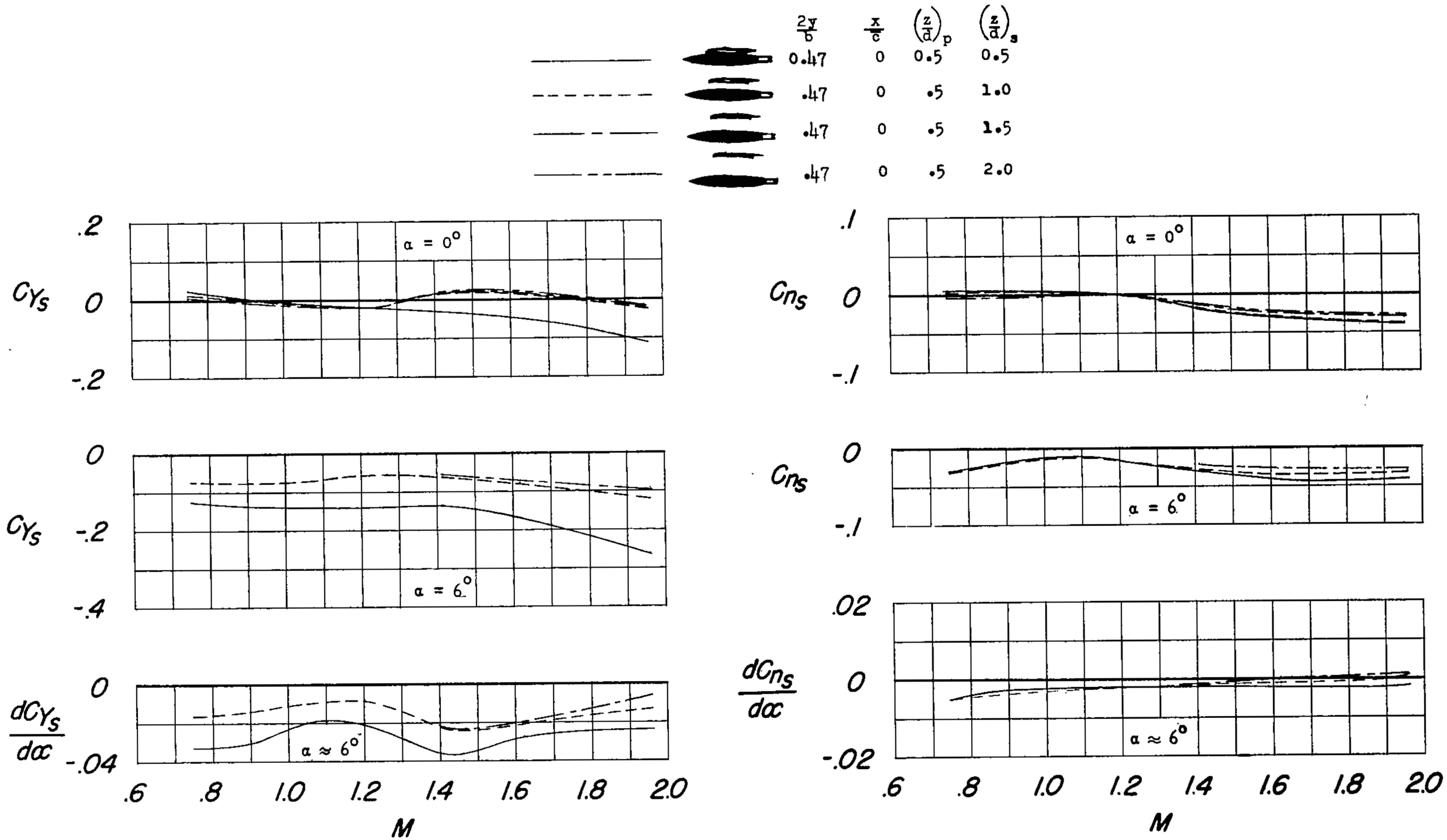
(a) Effect of vertical distance from the wing at $2y/b = 0.47$.

Figure 13.- Variation of DAC store normal-force coefficient and pitching-moment coefficient with Mach number.



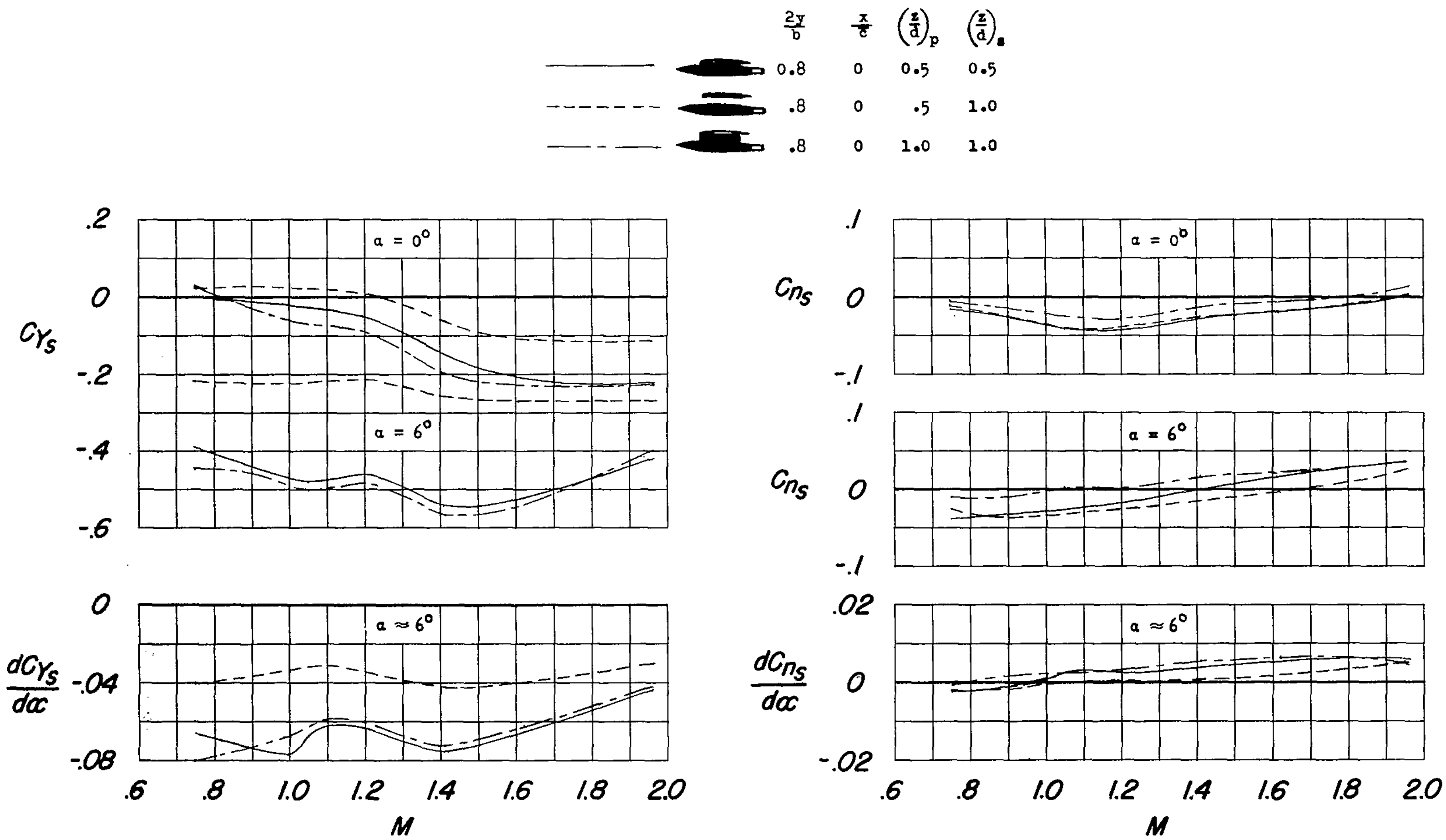
(b) Effect of vertical distance and effect of pylon at 2y/b = 0.80.

Figure 13.- Concluded.



(a) Effect of vertical distance from wing at $2y/b = 0.47$.

Figure 14.- Variation of DAC store side-force coefficient, yawing-moment coefficient, and slopes $\frac{dC_{Y_s}}{d\alpha}$ and $\frac{dC_{n_s}}{d\alpha}$ with Mach number.



(b) Effect of vertical distance and effect of pylon at $2y/b = 0.80$.

Figure 14.- Concluded.

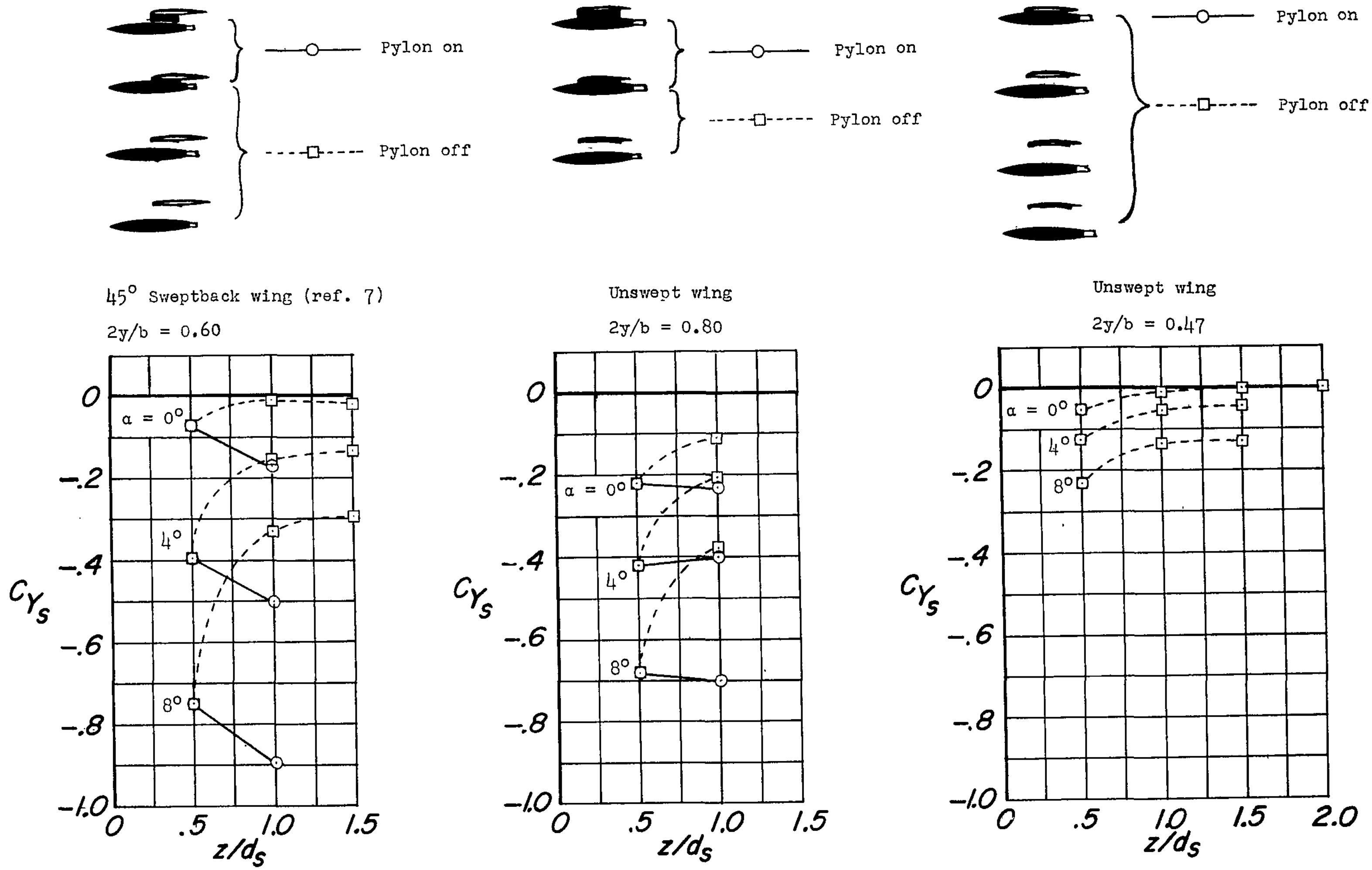
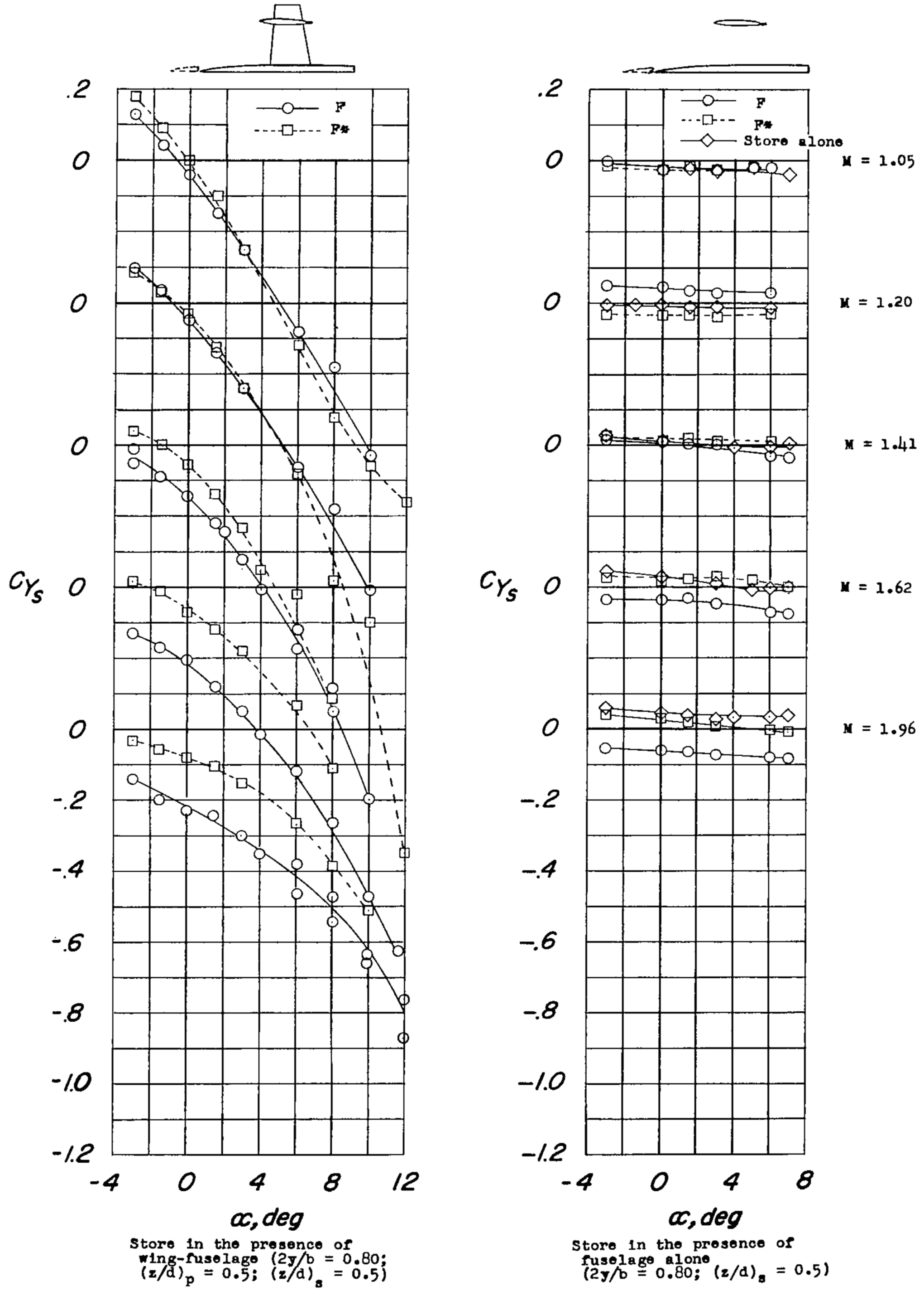
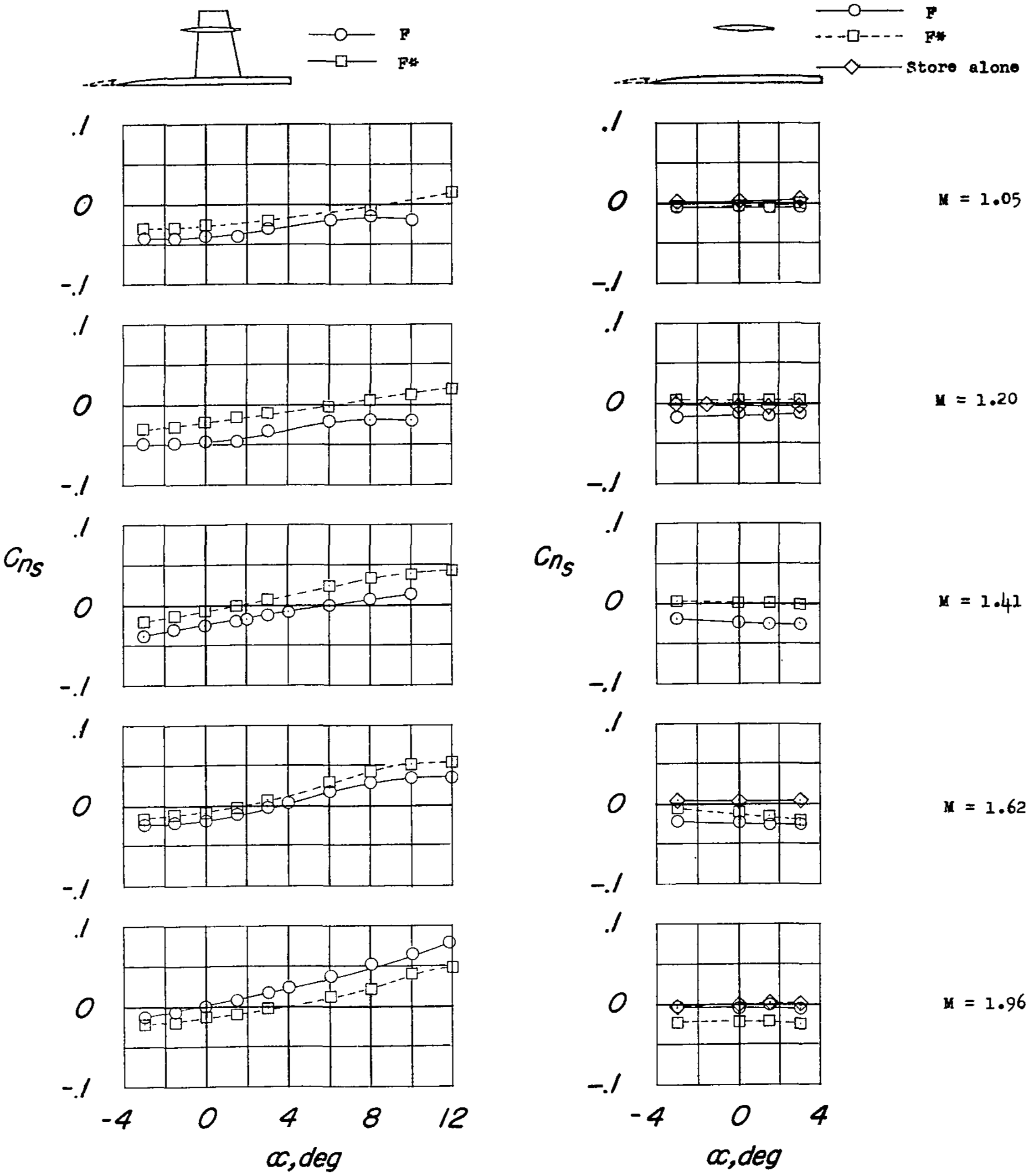


Figure 15.- Effect of pylon on store side-force coefficient. M = 1.62.



(a) Side-force coefficient against angle of attack.

Figure 16.- Effect of fuselage-nose position on store side-force and yawing-moment coefficients.

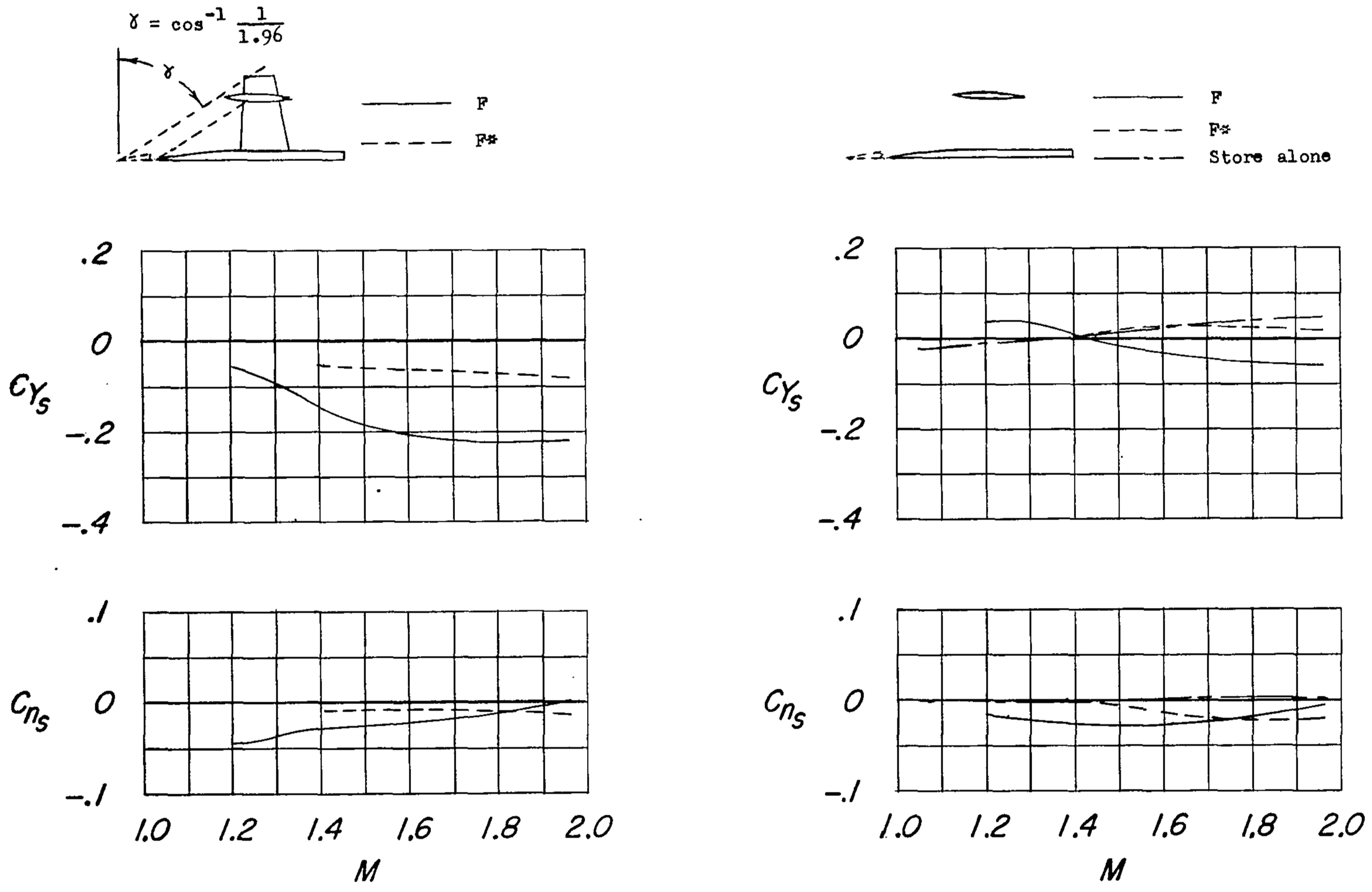


Store in the presence of wing-fuselage ($2y/b = 0.80$; $(z/d)_p = 0.5$; $(z/d)_s = 0.5$)

Store in the presence of fuselage alone ($2y/b = 0.80$; $(z/d)_s = 0.5$)

(b) Yawing-moment coefficient against angle of attack.

Figure 16.- Continued.



Store in the presence of wing-fuselage ($2y/b = 0.80$; $(z/d)_p = 0.5$; $(z/d)_s = 0.5$)

Store in the presence of fuselage alone ($2y/b = 0.80$; $(z/d)_s = 0.5$)

(c) Variation of store side-force and yawing-moment coefficient with Mach number ($\alpha = 0^{\circ}$).

Figure 16.- Concluded.